Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/GB05/001111

International filing date: 23 March 2005 (23.03.2005)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0406451.5
Filing date: 23 March 2004 (23.03.2004)

Date of receipt at the International Bureau: 24 May 2005 (24.05.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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   Patents ADP number *(if you know it)* 08347090001

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Keyboards

The present invention relates to keyboards and particularly, but not exclusively, to keyboards having improved key functionality and layout and improved software drivers.

The industry standard keyboard layout that possesses a virtually complete monopoly is the QWERTY keyboard. The QWERTY keyboard is a throwback to the days of mechanical typewriters and was designed to maximise the separation of the most frequently used key combinations in order to reduce jamming of the typewriter mechanism. Consequently, the keys that are most frequently used in combination are not arranged with ease of accessibility in mind and productivity is adversely affected.

Alternative keyboard models to the QWERTY layout are available, e.g. the Dvorak and Maltron models. These alternatives have sought to overcome the problems associated with QWERTY by respectively re-

positioning the most frequently used letters of the English language in the "home row" and by curving the keyboard to fit natural finger movements. Whilst these alternative models have succeeded in increasing typing speed and reducing muscle related fatigue and stress, they have remained in the minority due to the difficulties associated with users relearning or adjusting to an unfamiliar keyboard orientation. Consequently, keyboards have continued to develop predominantly around the familiar QWERTY layout.

The growing demand for rapid data entry into computers and the increase in complex combinations of keystrokes required by modern software applications have been the driving factors behind the development of ergonomic keyboards which maximise user comfort. Several attempts have been made to achieve this goal for both able and disabled users through the appropriate positioning of keys, manipulation of keyboard consoles (i.e. splitting the console into left-hand and right-hand portions) and the implementation of ergonomic contours for comfortable hand and finger placement.

Such improvements to keyboard design have succeeded to a limited extent in improving user comfort but to date have failed to couple this with significant improvements to keystroke efficiency and flexibility.

According to a first aspect of the present invention there is provided a keyboard comprising an array of productivity keys arranged substantially centrally on the keyboard wherein each key has at least one form of indicia disposed thereon corresponding to the key-value, said array comprising a plurality of rows and columns, said rows and columns being substantially mutually perpendicular and wherein the shape of the array and the positioning of each productivity key within the array is adapted to minimise finger extensions and promote efficiency in the typing of character strings.

Preferably, the array comprises two rows each of which intersects with two columns.

Preferably, four productivity keys are provided in each row and in each column of the array.

Preferably, the two columns are non-adjacent.

Preferably, the first and fourth keys of the first and second rows intersect with the second and third keys of each column respectively to form an H-shaped array.

Preferably, at least one of the productivity keys are composite keys having at least primary and secondary key values.

Preferably, the primary key value disposed on the productivity keys are in the form of a digraph or a trigraph.

Most preferably, each primary key value is a digraph selected from the group comprising OF, OR, IN, EN, ES, RE, TH, AT, ED, ER, ON and AN.

Preferably, the secondary key value disposed on the productivity keys is an internet command component selected from the group comprising ".tv", ".info", ".org", ".edu", ".gov", ".mil", "www.", ".co", ".ac", ".ccode", ".net" and ".com".

Preferably, the ordering of the productivity keys within the array is adapted to accord with a statistical extrapolation of the most used characters, digraphs, words and application specific data used in any given language.

Optionally, the productivity keys have graphically and dynamically programmable liquid crystal display (LCD) key-tops.

Preferably, the graphically and dynamically programmable liquid crystal display (LCD) key-tops are programmed and controlled in real time by a user and/or an active software application.

Optionally, the productivity keys are represented on a programmable touch screen.

According to a second aspect of the present invention there is provided a keyboard comprising at least one function key operable in combination with the productivity keys of the first aspect and each adapted to access a secondary key value.

Preferably each function key is additionally adapted to act as a conventional SHIFT key when operated in combination with non-productivity keys.

According to a third aspect of the present invention there is provided a keyboard comprising at least one function key which is user-configurable and selectively operable to delete n characters, words, sentences or paragraphs.

Preferably, for characters, the value of n is between 2 and 16.

Preferably, for words, the value of n is between 1 and 8.

Preferably, for sentences, the value of n is between 1 and 4.

Preferably, for paragraphs, the value of n is 1 or 2.

Preferably two function keys are provided for left-to-right and right-to-left deletion respectively.

According to a fourth aspect of the present invention there is provided a keyboard comprising a plurality of calculator-keys/buttons, a plurality of control-keys/buttons and a liquid crystal display (LCD), a subset of said calculator-keys/buttons having calculator-related key values and a subset of said control-keys/buttons operable in combination with said subset of calculator-keys/buttons to (i) selectively relay calculator-related key values to a computer; and (ii) selectively perform mathematical calculations and display the results of said calculations on the LCD display and/or relay said results to a computer.

Preferably, the calculator-related key values are selected from the group comprising 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., +, -, /, *, C/AC, MKUP, %, √ and +/-.

Preferably, the subset of control-keys/buttons can toggle between activated and deactivated states.

Preferably, the subset of control-keys/buttons comprises (i) a CALC LK button for selectively displaying the results of calculations performed using the calculator-related key values on the LCD display; and (ii) a NUM LK key for selectively relaying the results of calculations performed using the calculator-related key values to a computer.

Preferably, when both the CALC LK key and the NUM LK key are in deactivated states the calculator-related

key values themselves are relayed to a computer without performing calculations.

According to a fifth aspect of the present invention there is provided a software driver for a computer keyboard, said software driver being user-configurable and adapted to selectively provide keyboard functions and/or modes which extend keyboard functionality and facilitate increased user typing productivity.

Preferably, the software driver is user-configurable during pre and post driver installation.

Preferably, the software driver modes can be parameterised by the user during installation and/or run time configuration.

Optionally, the software driver comprises a double-press mode wherein a single-press of a keyboard key selects a primary key value/function and wherein a double-press selects a secondary key value/function.

Preferably, the secondary key value/function of each key is identical with the SHIFT value of that key.

Preferably, each double-press must be completed within a predetermined period of time in order to select the secondary key value/function.

Optionally, the software driver comprises a multi-press mode wherein each successive press of a

keyboard key up to n times selects a different character string stored within an installed dictionary, said character string having an initial letter or letters corresponding to the primary value of that key.

Optionally, the installed dictionary is an editable user-defined dictionary.

Preferably, one or more additional dictionaries can be user installed.

Preferably, the character strings are in the form of words, phrases, abbreviations, mnemonics or commands.

Optionally, the dictionary can be adapted to store definitions or descriptions of each character string.

Preferably, the definitions and descriptions are user-editable.

Preferably, once successive presses of the keyboard key cycle through all character strings retrieved from the dictionary, a further press reverts to the first character string.

Preferably, the multi-press mode remains active until a user types a SPACE or other non-character key.

Preferably, the length of the character string retrieved is at least n+1 characters in length.

Preferably, character strings retrieved are actively prioritised within the dictionary according to frequency of use.

Preferably, the maximum value of n is user definable.

Most preferably, the maximum value of n is selected from the group comprising 2, 3, 4, 5 and 6.

Preferably, the multi-press mode overrides the double-press mode if both are implemented simultaneously.

Optionally, the software driver comprises a translation mode wherein a typed or selected character string is automatically translated according to a user-configured dictionary definition/description.

Alternatively, the translation mode can be adapted to automatically translate a definition/description into a character string according to the same user-configured dictionary.

Embodiments of the present invention will now be described, by way of example only, with reference to the following drawings in which:

Fig. 1 is a perspective view of a conventional computer keyboard;

Figs. 2a and 2b are perspective views of the keyboard of the first embodiment of the present invention showing the productivity keys in bold;

Fig. 2c shows the productivity keys of Figs. 2a and 2b in isolation;

Fig. 2d is a table listing the physical features of the keyboard of Figs. 2a and 2b;

Fig. 3 is a list of top level domain codes;

Fig. 4 shows three examples of internet URL addresses typed using the composite keys of Figs 2a and 2b;

Fig. 5 is a table outlining the limits available to the user with regard to the MULTI DEL and MULTI BSPC keys of the keyboard shown in Figs 2a and 2b;

Figs. 6a-i are graphs showing statistical information relating to the most used words and word components in the English language;

Figs. 7a-e are tables depicting first and second composite key configurations respectively of the keyboard shown in Figs 2a and 2b;

Fig. 8a is a perspective view of a calculator portion of the keyboard shown in Figs 2a and 2b;

Fig. 8b is a table showing the available calculator-related functions of the calculator portion of the keyboard shown in Fig. 8a;

Fig. 9 is a table showing examples of statistical extrapolations of the most commonly occurring language components for the English, French, German, Italian and Spanish languages;

Fig. 10a is a table showing examples of the operation of the translation mode;

Fig. 10b is a table showing the structure of dictionaries used to perform the translations shown in Fig. 10a;

Fig. 11 shows two tables which illustrate the mapping of key press events in a FIFO buffer;

Fig. 12 is a table illustrating the key-value mappings between these various keyboard styles; and

Figs. 13a-c are perspective views of keyboards of alternative embodiments of the invention having alternative productivity key layouts.

The present invention is directed to an ergonomic (accessibility) and efficient (productivity) keyboard for single and dual hand, full or limited

dexterity, and right or left hand orientation users as a Multi-Dexterous Productivity (MDP) Keyboard system which. Among its aims includes (i) the reduction of Repetitive Stress/Strain Injuries and other related ailments associated with keyboard use; and (ii) an increase in accessibility (ergonomics) and productivity (typing efficiency).

Fig. 1 shows a conventional keyboard according to the QWERTY layout standard. The keys are arranged in straight rows with a user's hands shown to illustrate the natural position of the fingers in a relaxed typing position. The tips of the fingers form a natural arc with respect to the keyboard by virtue of the differing lengths of the fingers and thumb of each respective hand. To conform to straight rows of keys of the key board, fingers are forced to be held in an unnatural position while poised over the row of conventionally designated "home keys". This unnatural position causes significant hand discomfort from repetitive key strikes and makes touch-typing more difficult due to the tendency of the fingers to stray or extend from the home row of keys. Thus the conventional straight line of home keys is a source of ulnar deviation and pronation both of which are causes of RSI for regular keyboard users.

Figs. 2a and 2b show a modified QWERTY keyboard according to a first embodiment of the present invention. The keyboard is arranged with a particular symmetry that enables it to be easily

split into three segments (as shown in Fig. 2b) to provide greater flexibility in approach and comfort, thus further enhancing ergonomics. Here, the first split would tend to be between the central two columns of the productivity keys (described below) and the other split would tend to be between the main keyboard section and the numeric/calculator section. This applies to all configurations of the MDP.

The keyboard comprises an array of "productivity" keys (shown in isolation in Fig. 2c) and disposed within a substantially central portion of the keyboard. Each key within the array of productivity keys has primary and secondary functional indicia disposed on its top surface wherein at least the primary functional indicia is statistically extrapolated (discussed later in more detail with reference to Figs. 6a-i). The primary form of functional indicia on each composite productivity key shown in Figs. 2a and 2b is in the form of two-character combinations (known as a digraph). However, other forms of primary functional indicia are possible and may be in the form of at least one of: characters (single letters, digraphs or trigraphs), words, word groups and/or special commands all of which serve to alleviate the recognised problem of repetitive key strikes and/or alleviate excessive redundancy, repetitive typing and/or optimise typing productivity based on the most commonly used characters, words, word groups and special functional commands of any given

language including (for example, English by default, French, German, Italian Spanish and other EU and international languages).

Each digraph is selected using the results of a statistical data study of the most commonly used words in the English language. The statistical data study has shown that the following digraphs (i.e. coupled letters) occur most commonly in the English language: OF, OR, IN, EN, ES, RE, TH, AT, ED, ER, ON and AN. In view of the fact that the Q key is rarely used singularly (according to the statistical studies discussed below) but is often paired with the letter U, a QU digraph key is provided. However, since this digraph is less common than the others, it is not included in the central productivity key array and retains the position of the conventional Q key (See Fig. 2c).

In an alternative embodiment (not shown), each set of characters, words or word groups are taken from a statistical data study of the most commonly used trigraphs (i.e. three-character combinations) such as QUE, QUA, QUI, THE, ETH, ITH, ION, ONE, TEN, ENT, END, ENV, FOR, TOR, TER, FER, GER, BER, INT, INY, REY, REG, GED, EDY, AND, ANY, ANI, etc. Experimentation has shown that the use of productivity keys using digraphs and trigraphs can reduce multiple key-strokes by up to approximately 30%.

Furthermore, the composite productivity keys shown in Figs. 2a and 2b have secondary indicia of the most used special software application based commands, acronyms and/or mnemonics, by default Internet URL commands (i.e. ".tv", ".info", ".org", ".edu", ".gov", ".mil", "www.", ".co", ".ac", ".ccode", ".net" and ".com").

These URL commands are all well known with the exception of the ".ccode" internet URL command. This secondary key value is user definable during the software driver installation or run-time configuration to correspond with the most commonly used top level domain (TLD) value. For example, if the keyboard is to be used in the United Kingdom, a user would select the United Kingdom from a list (as shown in Fig. 3) during installation or run-time configuration of the software driver thus assigning the value ".uk" to the .ccode key.

The productivity keys are configured to have default linguistic settings that are function key controlled. Whilst in normal mode, the default key-values of the productivity keys shown in Fig. 2c will be the digraph values. For example, pressing "EN" alone will give "en". Pressing the "SHIFT" function key in combination with key "EN" will produce "EN" in upper case. In Caps lock mode the values summoned would be "EN" and "en" respectively. Further composite keys include DUAL which accesses secondary key values and DUAL SHIFT which accesses and shifts on secondary key values. In normal mode

the "DUAL" key used in combination with key "EN" summons ".edu" and "DUAL SHIFT" summons ".EDU". Further examples incorporating usage of the .ccode key are shown in Fig. 4.

In the particular example shown in Figs. 2a, the productivity keys are arranged in substantially the central area of the keyboard in an array comprising two columns which intersect with two rows in a substantially mutually perpendicular arrangement, each row and column consisting of four productivity keys. The two rows lie adjacent to one another such that the first and fourth keys of the first and second rows intersect with the second and third keys of each column respectively to form an H-shaped array. In other words the first and fourth keys of the first and second rows are shared with the second and third keys of each column.

The H-shaped array means that a single or dual handed user has immediate access to the most commonly used characters and commands at his/her fingertips without unnecessary flexing or extensions beyond conventionally designated home keys. The most used or most frequently occurring productivity keys (derived from any given language statistical extrapolations or of general information) are positioned in order closest to the keyboard home keys F and J. In addition, a user is not presented with the drastic psychological factors of having to relearn how to use an unfamiliar style of keyboard since the familiarity of the QWERTY model is

retained and merely modified to improve efficiency and to reduce repetitive key strikes and the like to minimise Repetitive Strain Injuries (RSI).

Additional function keys which are operable in combination with the productivity keys (i.e. the BSPC (Backspace), DEL (Delete), DUAL and DUAL SHIFT keys are added to the array as shown more clearly in Fig. 2c to form an overall array comprising 18 keys (i.e. 4 function keys and 14 productivity keys - excluding the generic QU key but including the <space>T and E<space> keys described below).

The BSPC and DEL keys are well understood and require no further explanation and the DUAL and DUAL SHIFT keys have been described above. However, the "SPC T" and "E SPC" (i.e. <space>T and E<space>) keys are new keys which contribute to increased typing efficiency. A statistical analysis of the English language has shown that the most common characters which start and end a word in the English language are the letters "T" and "E" respectively. Space (SPC) delimits and/or indicates the start or end of a new word or a previous word respectively. Accordingly, these keys serve to provide a reduction in keystrokes in a similar manner to digraphs and so are notionally included within the group of productivity keys. These keys have secondary key values .biz and .pro respectively which are accessible using the DUAL keys as described previously.

Further functional keys (not shown in the example of Figs. 2a-c) can also be added to the array. For example, "iBusiness" and "iPersonal" keys are programmable keys via the software driver (during pre and post driver installation). In an alternative example (not shown) these keys replace the BSPC and DEL keys located at the top of the array shown in Figs. 2-c. The value of the iBusiness key is defaulted to the user's business web-site, e.g. www.keypoint-tech.com. The value of the iPersonal key is user-definable and is intended to default to a user's internet home URL setting. During installation or run-time configuration of the software driver these defaults can be amended by the user. URL validation will be made to verify the correctness of the URL format and page access (i.e. the URL is ping-ed). Changing the iPersonal key value will not affect the user's pre-existing internet home URL setting as these are maintained independently of one another. In operation, the software driver will therefore either feed the selected URL value into the internet browser address field (or into any cursor area during cursor/text input mode), or auto-startup a browser with the selected URL when not in cursor/text input mode.

Yet another pair of functional keys (again not shown in the example of Figs. 2a-c) can be added to the array. These are the "MULTI DEL" and "MULTI BSPC" keys respectively. Again, these keys contribute towards a reduction in keystrokes by deleting n characters, words, sentences or paragraphs at a time

either from left-to-right with MULTI DEL or right-to-left with MULTI BSPC. The user can associate n to either characters, words, sentences or paragraphs during software driver installation or run-time configuration.

The table shown in Fig. 5 outlines the limits available to the user with regards to the value of n relative to the corresponding entity assigned to the MULTI DEL and MULTI BSPC keys respectively. The adjacency between entities is delimited as shown in the table and is relative to the current cursor position and/or within dynamically highlighted sections(s) selected by the user within a current active software application.

Optionally, it is envisaged that the productivity keys of the first embodiment could be provided with graphically programmable liquid crystal display (LCD) key-tops (or a touch screen) which are dynamically programmable in real time. The keyboard software driver would be adapted to have a two-way channel that dynamically programs the indicia of the keys, or touch screen representations thereof, in real time according to the current software application in use.

It will be appreciated by those skilled in the art that the functionality and layout of the productivity keys of the first embodiment will minimise Repetitive Stress Injuries (RSI) such as Carpel Tunnel Syndrome (CTS) and other Cumulative

Trauma Disorders (CTD) such as Musculoskeletal Disorders (MSD), Occupational Overuse Syndrome (OOS), Repetitive Motion Injury (RMI), Upper Limb Disorder (ULD), etc in dual or single handed keyboard users, full or limited dexterity keyboard users and left or right hand oriented keyboard users. The primary difference being that a user now has an optimally arranged set of keys formed with statistically extrapolated indicia or characters and special commands which significantly reduces unnecessary finger extensions and related fatigues beyond a user's hand span. Additionally, workload is reduced thereby reducing or pre-empting stress and/or strain.

Since each language whether English, French, German, etc. has distinct linguistic characteristics inherent to its etymology and principal area of technological or otherwise application of origin, it would be obvious to one skilled in that language to construct special primary commands to provide the necessary functions and language based commands. In this regard, numerous key orientations are possible, excluding those orientations which minimise typing speed, and detract from preventing repetitive key strikes which can lead to RSI, and potentially decrease efficiency (productivity). The tables in Fig. 9 show examples of statistical extrapolations of the most commonly occurring language components for the English, French, German, Italian and Spanish languages.

A closer look at statistically extrapolated character, word and/or command data or indicia is shown in Figs. 6a-i. Through the analysis and weighting of the most common usage in English, combinations or subsets of letters, digraphs, tri-graphs and small words can be extracted. The exclusive union of these categories (frequency, union), filter out duplications of 1 to 3 letters from each respective subset resulting in a compacted optimal mix of combinations that can be used in keyboard design applications to recreate fuller words thereby minimising repetitive keystrokes and associated injuries. For instance in Figs. 6a-i, it is shown that the most popular combination of digraph is TH, for tri-graph it is THE and the most used letter is E. The succinct union of these combinations, in turn are process similarly with other unions and the final remaining contents (superset) listed as the most likely candidates that can be use to reduce key strikes or strokes, repetition and key reaches.

As depicted in Fig. 6a, a table generated from a variety of studies shows the most common weight of letters and there frequency of use. As shown therein the letter E had the highest frequency as the most used letter in the distribution of data. As depicted in Fig. 6b, the table shows the letter T as having the highest percentage frequency of most used letters that start a word. As depicted in FIG. 6c, the table shows that the letter E as having the highest percentage frequency of the most used

letters that end a word in English. In order to generate the most effective union of the selective data, a criteria is imposed to systematically eliminate the less frequent letters and leave only the most popular ones. These in turn, are used in the final selection and optimisation of a superset. This can be seen more clearly in the combinations obtained from a digraph depicted in Fig. 6d. Digraphs are combinations of 2 alphabetic letters that are coupled together and occur commonly in words particularly in the English language. The table shown here shows TH, ER, ON, and AN as having the highest percentage frequencies amongst an entire distribution of likely candidates. Similar analysis are performed for more than two letters or tri-graphs depicted in Fig. 6e. Tri-graphs are combinations of three alphabetic letters that are grouped together and occur commonly in the English sample set. As shown in the table of Fig. 6e, the three letter word THE is shown as having the highest percentage frequency with AND as next likely candidate for selective combinations. As indicated by the table selecting the most prominent and primary tri-graphs with frequency values greater than 6.10, along with a secondary set with frequency values between 5.00 and 6.10 optimum tri-graph sets can be obtain (e.g. primary set: AND, ENT, FOR, ION, THE, TIO; and secondary set: EDT, HAS).

As depicted in Fig. 6f, the table shows the percentage frequency of the most used words of the English language as the sample set wherein words

such as AND, IN, OF, THAT, THE, and TO were optimally obtained imposing the criteria of frequency values of greater than 0.9 to obtained the discrete word set. The percentage frequency of words that are two or more letters in length strongly indicates that the bulk of keyboard operations requires repetition and multi-strokes. As depicted in Fig. 6g, the recorded data shows a distribution curve which indicates that the main weight in frequency is consumed by words of two to five letters in length, which represents 74.17% of a possible workload. The introduction of the optimised frequency union from letters, digraphs, tri-graphs and small words significantly reduces this workload by simply eliminating unnecessary typing. Accordingly, this inherently reduces the risks associated with the duration of keyboard operations and subsequently diminishing RSI and elevating productivity.

As depicted in Figs. 6h and 6i, keystroke reduction is shown for the most common tri-graphs and most common words, respectively. The select combination from the frequency union also includes OF, OR, IN, EN, ES, RE, TH, AT, ED, ER, ON and AN. For example, the use of the tri-graph AND indicates a keystroke reduction of 14.55 keystrokes out of a sample of 100 words. Using the most common word groups the same word AND indicates a greater keystroke reduction of 28.30 keystrokes out of a sample of 100 words.

Figs. 7a and 7b illustrate the composite key

operations for various key value combinations of a specific set of data in normal typing mode and utilising the function keys SHIFT, DUAL and DUAL SHIFT under Normal and Caps Lock mode. As set forth in Fig. 7a, composite key operations performed are tabulated for exemplary letter (t,T), Symbol (3,#), and productivity (th,TH,www.) key sets. These sets represent the default pair of primary and secondary values (and tertiary values for the productivity key), respectively, for their assigned keys in normal typing mode. Note in capitalisation mode the primary and secondary productivity keys are reversed. The Shift key will work normally as used in existing keyboard operations. The Shift key uses the secondary letter key values. The Dual/Dual Shift keys work only with the secondary or tertiary key values. According to the invention, the pair value for the Q key has been changed and reversed since the letter Q is rarely used singularly and is primarily paired with letter U to form the majority if not all, fixed QU words. Thus, the qu is the primary value, QU the secondary value and q the tertiary value. For the productivity key data (th,TH,www.) in normal mode, pressing the productivity key in normal mode summons "th", pressing the SHIFT in combination summons "TH", pressing the DUAL key in combination with the productivity key summons "www." and pressing the Dual Shift key in combination with the productivity key summons "WWW." as the normal mode protocol. In caps lock mode, the results for the productivity key

data set are respectively the reverse.

As set forth in FIG. 7b, an enhanced data set is shown wherein the Letter, Symbol and productivity key data sets include three assigned values in normal mode, respectively (t,T,the), (qu, QU, q) and (th,TH,www.). Here the influence is the set (t,T,the), which permits normal keys to also have most used word, phrase, abbreviation, mnemonic or command associated with it as a DUAL or DUAL SHIFT accessed key-value. Similarly, function key utilisation according to the above reference protocol can be evaluated by using the key data (t,T,the). In normal mode, pressing the key in normal mode summons "t", pressing the SHIFT in combination summons "T", pressing the DUAL key in combination with the key summons "the" and pressing the DUAL SHIFT key in combination with the key summons "THE" as the normal mode protocol. In caps lock mode, the results for the key data set are also respectively the reverse. The tables in Figs. 7c-e show full mappings for all other keys.

The primary advantages of the productivity (efficiency) and ergonomic (accessibility) keyboard, includes the aspects of ergonomics which serve to optimise efficient key access by maximising comfort and minimising unnecessary keystrokes. Inherent to these particular factors includes comfort by retaining the most neutral body positions and by encouraging minimal body movements. The primary focus being to substantially reduce the likelihood

or probability of acquiring injuries or disorders by minimising stress and fatigue related various parts and muscle groups of the body such as ligaments, musculoskeletal joints, muscle tendons, hand nerves, and neuromuscular trigger points. In this regard, the invention is directed towards merging the needs of able and disabled persons to provide a keyboard which optimises efficient keyboard use and levels the keyboard playing field to include an added benefit of diminished RSI and elevated productivity (increased work throughput).

To this end, it is important to differentiate between the use of a software application and its purpose. The use of the application is defined by the physical operations or functions available via the application interface, keyboard, and pointing device, which help fulfil the purpose of the application. The purpose of an application is its objective to meet user requirements, and to parameterise its use. Mechanisms that enhance the purpose of applications provide diverse or greater methods of application use. This in turn makes the interface, and its keyboard and pointing device, more efficient and effective.

Current keyboards only provide the mechanism to use the applications. The use of the application is determined by the predefined user-permitted operations of the applications that allow it to fulfil its purpose. Thus, current keyboards are limited to one-way feeds, from keyboard to

application, and do not provide the scope to improve or diversify the application interfaces that would otherwise allow for enhancements to application purpose. For example, in word-processing, all the operations allow one to format and present a document that forms the basis of the applications use. The purpose of the application is to enter text, based on language. Thus, the breakdown of language into its bare components, which are letters, digraphs and trigraphs etc., would provide a more efficient and easier mechanism to fulfil the purpose of the application. This also permits the application to diversify its functionality and enhances the versatility of what the application can do with its interface. The same principles can be applied to any software application such as financial trading systems, Internet browsers and the like. The ability of the MDP Keyboard system of the present invention to enhance not only application use but also application purpose, via the unique productivity keys, improves user interfaces that permit applications to operate more effectively and efficiently with application diversity and versatility. The MDP ideology connects the user with the software applications at the information level, thereby fulfilling more the purpose than the function.

Fig. 8a shows a calculator portion of a computer keyboard according to a fourth embodiment of the present invention. Conventionally, the NUM LOCK key of a computer keyboard activates calculator and/or

numeric keypad features. The calculator portion of the keyboard according to the present invention has been provided with a more sophisticated functionality and arrangement.

The keyboard shown in Fig. 8a as a plurality of keys and an LCD display. A first subset of said keys corresponds to those responsible for calculator and/or auxiliary functions. A second subset of said keys are operable in combination with the first subset to determine (a) whether calculator-related or special characters are displayed on the keyboard's LCD display and/or on an alternative display such as a Visual Display Unit (VDU); and (b) whether the results of mathematical calculations performed by the calculator keys are displayed on the keyboard's LCD display and/or on an alternative display such as a Visual Display Unit (VDU).

In addition to the numeric key-values 0-9, the functional indicia of the first subset of keys comprise any or all of the following: +, -, /, *, MR, M+, M-, MC, C/AC, MKUP (Mark Up), %, √ and +/-.

The second subset of keys consists of the following two keys each of which can toggle between activated and deactivated states: the "CALC LK" key and the "NUM LK" key. The CALC LK key selectively enables and disables the calculator and numeric keypad functions of the calculator portion of the keyboard. The NUM LK key selectively relays the results of calculations performed using the calculator or

numeric keypad operations to a computer for display on a VDU. Finally, the combination of the CALC LK and the NUM LK keys selectively displays the results of calculations performed using the calculator or numeric keypad operations to the LCD display on the keyboard. When the computer itself is turned off, the CALC LK key can be used to activate or deactivate the keyboard calculator for use as a standalone desktop calculator. This feature does of course rely on the keyboard having its own battery or solar cell for powering the calculator.

The CALC LK and NUM LK keys can each be selectively activated or deactivated to produce, in combination, four distinct functionalities. As shown in the first row of the table in Fig. 8b, when the respective two keys are in an ON-OFF state, the first subset of keys perform calculations which are displayed only on the keyboard LCD without being relayed to the computer. The ON-ON state shown in the second row allows the first set of keys to perform calculations which are both displayed on the keyboard LCD and relayed to the computer for display on a VDU. When in the OFF-OFF state shown in the third row, special characters are relayed to the computer for display on a VDU without performing any calculations. Finally, when in the OFF-ON state shown in the fourth row, the first subset of keys perform calculations which are only relayed to the computer for display on a VDU without also being displayed on the keyboard LCD (i.e. just like a conventional keyboard).

In addition, the calculator is provided with a retention buffer which holds a calculation history of, for example, 64 items including the most recent numeric entries, operators and equated values. It should be noted that the retention buffer is totally separate from the standard calculator memory operated using the conventional memory buttons (i.e. M+, M-, MR, MC). The retention buffer allows a user to scroll through the entries stored in the buffer using the UP and DOWN arrow keys, whereby each scrolled entry is respectively displayed on the LCD display. Such functionality allows the user to regress, recur and/or rectify calculations from any previous point within the buffer. In this way, all new entries from a regressed, recurred and/or rectified point overwrite respective/consequent older entries within the buffer.

Computer keyboard software drivers are essential in all operating system (OS) environments, their function being to convert keystrokes to OS language tables, thus bridging or translating required notation within all human-to-computer interfaces. It is important to note that the software driver is a critical element to keyboard function and operation and that the additional features of the software driver of the present invention is also operable with, and can be extended to, all currently available keyboard drivers.

Conventional keyboard drivers merely map key legends to OS language tables with little or nothing in the way of sophisticated extensions or add-ons to improve performance, versatility and adaptability of the keyboard medium.

However, the software driver of the present invention is adapted to implement the enhanced features of the other aspects of the present invention leading to increased typing productivity and keyboard adaptability and versatility. The keyboard software driver of the present invention includes a number of optionally activated and configurable modes including a "double-press mode", a "multi-press mode" and a "translator mode" (operable with a user-configurable dictionary). These modes or features accumulate, grow and maintain all dictionary information, including "frequency", which inherently facilitates overall intelligence permitting the MDP to adapt to the user's habits, behaviours and working environment. All three modes constitute additional features over conventional keyboard software drivers which result in improvements to typing productivity and adaptability and versatility. The aforementioned modes are described in detail below.

The double-press mode allows a user to select one of two alternative key values/functions depending upon whether a key is pressed once or twice within a predetermined time period (i.e. similar to the double clicking of a mouse). Normally, the two

alternative key values will be (i) the normal key value (i.e. the value obtained when no function key is used in combination with it); and (ii) the SHIFT value of that key. For example, a single press of key "A" yields key value "a" (i.e. lower case normal key value) whereas a double-press of key "A" yields key value "A" (i.e. upper case - SHIFT-"A" key value). Of course, the keyboard driver could be adapted such that the second press of a key in double-press mode selects any other alternative key value other than the SHIFT value such as, for example, the DUAL or DUAL SHIFT value.

The multi-press mode is a natural extension of the double-press mode and allows the rapid pressing of a key up to n times to successively select a different word stored within an actively prioritised user-installed dictionary. For each letter key the multi-press prioritisation is set first by the length of a character string, such as a word, (beginning with the relevant letter) and then by its frequency of use by the user. In order to gain any productivity benefits from the multi-press mode, successive multi-presses must retrieve character strings which (i) are actively prioritised by frequency of use (either per session or in real time); and (ii) are of a character length greater than or equal to n+1.

For example, a user can toggle between and/or dynamically integrate different user-installed dictionaries. Dictionaries may consist of mobile

texting mnemonics, abbreviations, industry specific jargon such as medical acronyms etc. Prioritisation of each word/mnemonic is updated each time it is selected or typed or scanned or used to event an occurrence thereof. An optional feature is the storage of any new words within the dictionary (with NULL description).

An extension of the multi-press mode is a translation mode which can be set during installation or run-time configuration to one of the following conditions: OFF, Translate+ (i.e. translate maximise) or Translate- (i.e. translate minimise). When set at Translate+, any character string (for example, a word or mnemonic), whether selected using the multi-press mode or not, will automatically expand into definition/description stored within a dictionary. Alternatively, when set at Translate-, any character string (for example, a phrase or a sentence) will automatically contract into a shortened version (for example, an abbreviation or an acronym) stored within a dictionary. Accordingly, the translation mode performs two-way translations depending upon the particular settings chosen by the user. Examples of the operation of the translation mode are shown in the table in Fig. 10a. As illustrated in the table of Fig. 10a, translations can be performed using a variety of configurable dictionaries which are run-time user configurable or downloadable from the internet in real time. Examples of dictionaries

used to perform the translations shown in Fig. 10a are shown in Fig. 10b.

The dictionaries are used to determine user typing habits and behaviour and adapt the MDP keyboard to the user environment dynamically. This reduces excessive repetition and redundancy within typing, thus further improving productivity (efficiency) and accessibility (ergonomics). It will be appreciated that further Flag/Type indicators may evolve in the future. Many dictionaries can be configured at any one time and each can be of a different type. Duplications of mnemonics are replaced by newer installed dictionaries either automatically (i.e. by keeping the entry with the highest frequency) or by user choice. All dictionaries are dynamic and therefore can be duplicated into various other languages or downloaded from the internet and configured during run-time.

As shown in Fig. 10a, dedicated keys or buttons are provided on the keyboard. The multi-press key/button and the Trans mode keys/buttons are used to toggle between activated and deactivates states respectively. Regardless of whether the translation mode is set to Translate+ or Translate- or OFF, a user can manually highlight a section of text and press the Translate+ or Translate- key to perform an appropriate translation without overriding the otherwise automatic operation of the translation mode. Indeed manual use of the Translate+ and Translate- keys in this fashion can also be used

when the automatic translation mode has been set to OFF.

The MULTI DEL and MULTI BSPC keys (described above) behave slightly differently when used immediately after a translation has occurred. For instance, when the translation mode is active, the character string "call me asap." automatically expands to "call me as soon as possible." if the character string ends with a non-character SYMBOL (in this case a full-stop). The immediate use of the MULTI BSPC key at this point would firstly revert back to "call me asap" before fully functioning as a multiple backspace (i.e. deleting the whole sentence" configured by the user. In the same scenario, a regular backspace key would function as normal and singularly delete characters from right to left.

The keyboard software driver also opens a separate installation or run-time configuration window when in multi-press mode giving a range of user-definable options. For example, a user can select the maximum value of n, whereby n is the number of most used words to be retrieved from the dictionary during multi-press mode. Normally, the maximum value of n would default to n=4 but could be within the range 2-6. A check box is provided to enable or disable the multi-press mode functionality when a key is double pressed only (i.e. without a third press within a predetermined period of time from the second press).

The keyboard software driver is of course provided with user-definable speed settings for the double-press and multi-press modes, much like those provided for double-click setting for a mouse. Furthermore, the software driver also provides options for cursor selection in order that a user can visually determine whether or not the double-press or multi-press modes are active. It will be appreciated by those skilled in the art that the double-press and multi-press modes are particularly beneficial to users having limited use of the fingers.

The MULTI DEL and MULTI BSPC keys can be adapted to operate in the translator mode to successively revert from the stored definition/description of a word to the word itself (i.e. upon a single press) and then delete both the definition/description and the word itself (i.e. upon a second press).

The software driver performs the mapping of keyboard signals which are buffered on a First-In-First-Out (FIFO) basis. Fig. 11 shows two tables which illustrate the mapping of key press events in a FIFO buffer for the typing sequence "Here's another query" (where underlined letters correspond to the digraphs on the appropriate productivity keys of the first aspect). Although the FIFO buffer will almost always be empty since all key-press events will be mapped and dispatched immediately to the operating system and receptive software application, a

temporary buffer to store pending characters is recommended to alleviate any possible operating system of software application delays or latencies or conflicts.

Fig. 11 also shows a schematic operating scenario for a FIFO buffer in "piped multi channel" mode. The multi channel mode operates when the key value FIFO buffer is used simultaneously by two or more software applications. The multi channel mode will be specifically useful for use with the enhanced software driver of the present invention. The piping of the buffer as depicted in Fig. 7b helps avoid buffer complexity, conflict or contention issues particularly during simultaneous use by two or more software applications.

An alternative multi channel mode can also be implemented by duplicating the key value FIFO buffer thus providing a secondary channel for the input of a second software application. The secondary key-value FIFO buffer is always a dynamic replication of the primary key value FIFO buffer. The primary and currently active keyboard application is the only application that can pop/push/flush the primary key value FIFO buffer. A secondary software application cannot pop/push/flush either key value FIFO buffers. The secondary software application may only feed from the secondary key value FIFO buffer. Such rules ensure that no conflict or contention issues occur regarding the key value FIFO buffer. An alternative is to make the key value FIFO buffer

shareable whilst still applying the above rules to give control to the primary software application. All other secondary applications simply feed off the key value FIFO buffer.

The features of the present invention could equally be incorporated into alternative keyboard styles, for example, the Maltron and Dvorak keyboards styles. The keyboard software driver is provided with a radio button(s) in order that a user may select toggle between the QWERTY, DVORAK dual-handed, DVORAK left-handed and MALTRON keyboard layouts. Fig. 12 is a table illustrating the key-value mappings between these various keyboard styles.

Modifications and improvements may be made without departing from the scope of the present invention. For example, the rows and/or columns of the array of productivity keys of the first embodiment may be slightly offset whilst retaining their overall shape.

The productivity key indicia can be adapted to suit the particular requirements of the application being used (i.e. different languages, computer programming languages etc.). Productivity keys can be arranged in different ways and layouts to cater for a variety of desktop needs, compactness, notebooks, portability and programmability etc. See, for example, the alternative layouts shown in Figs 13a-c.

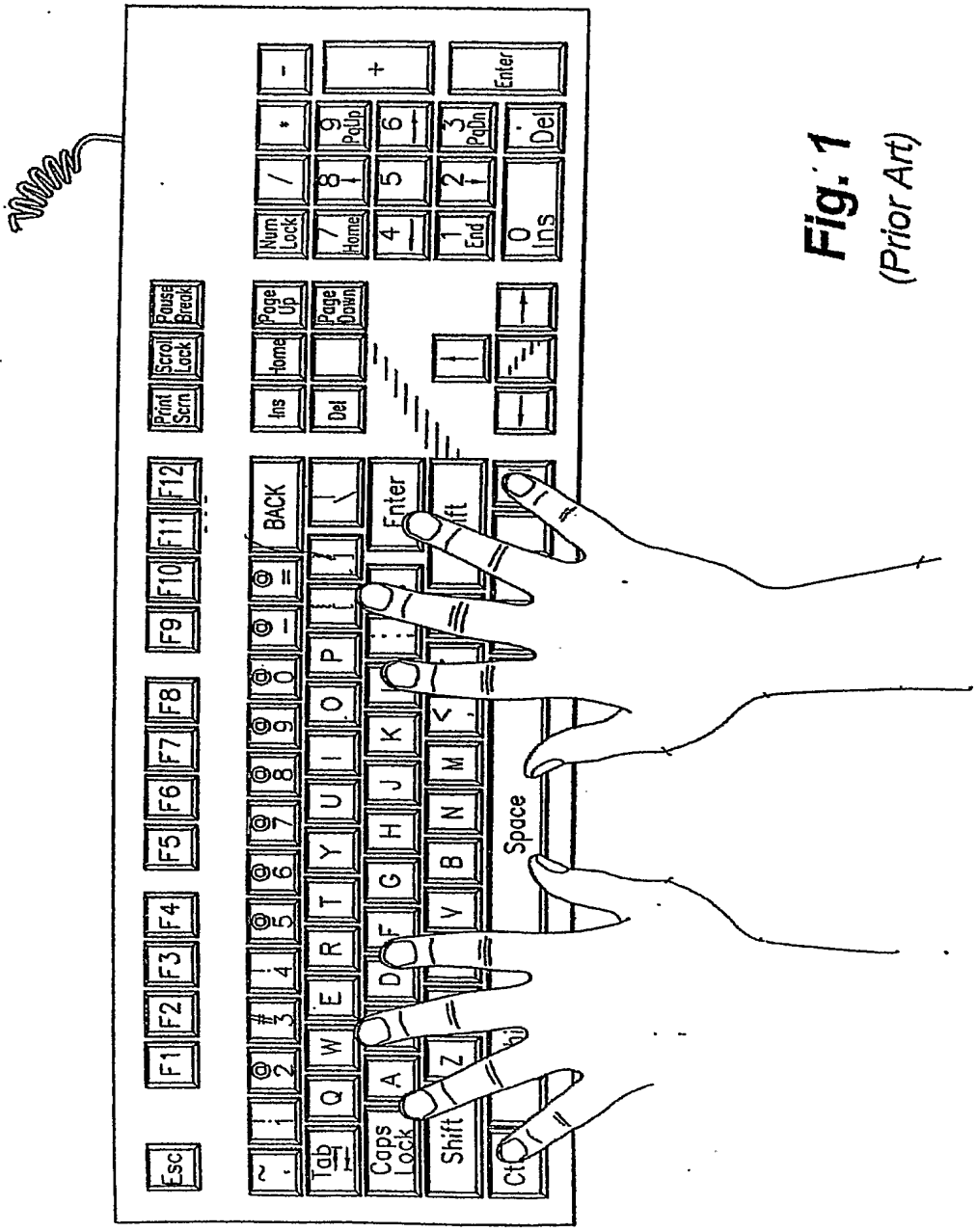


Fig. 1
(Prior Art)

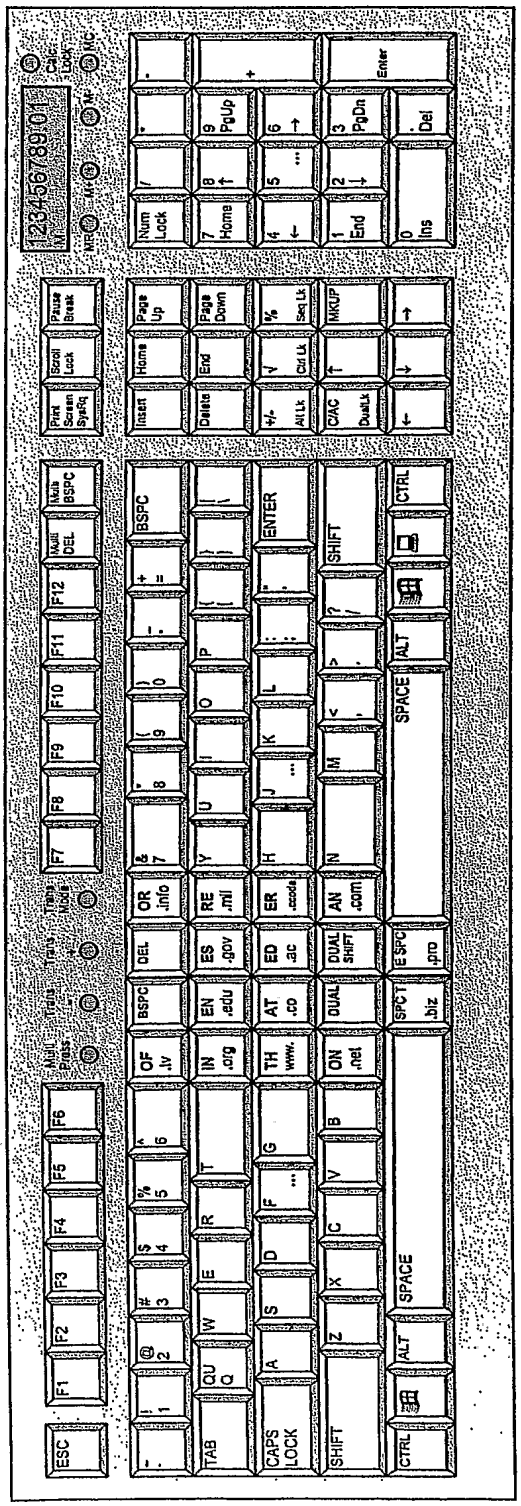


Fig 2a

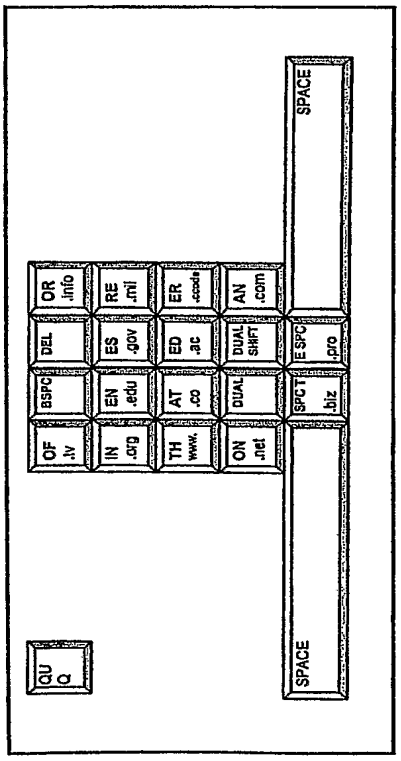


Fig 2c.

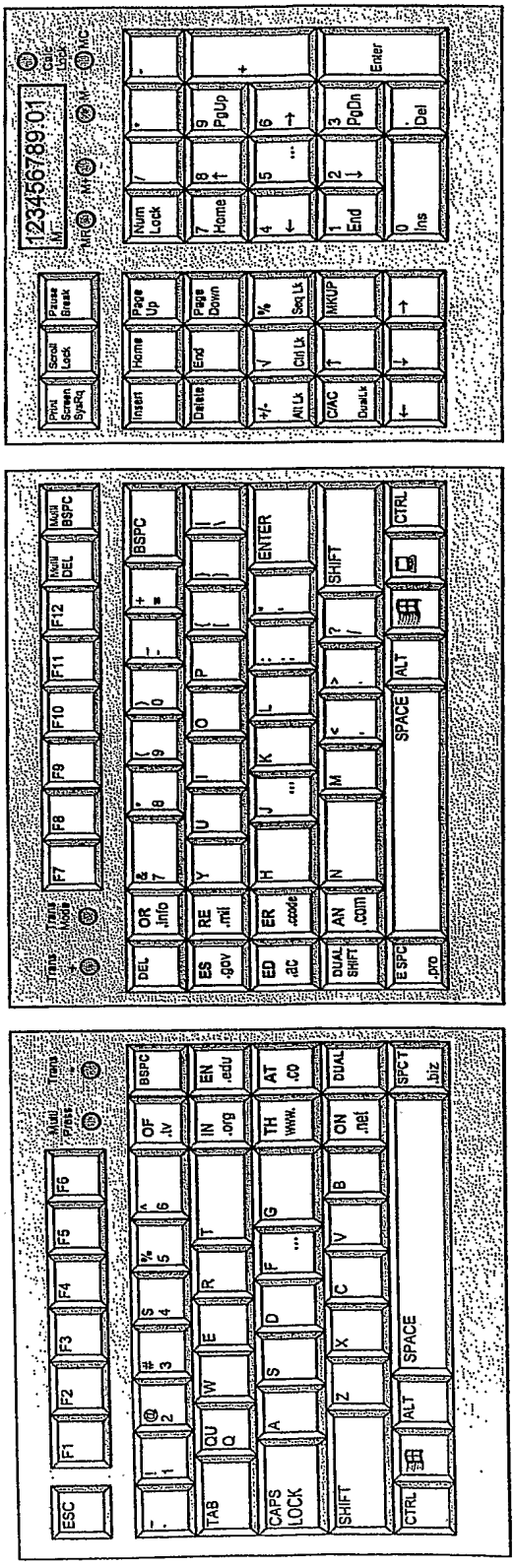


Fig. 2b

List of **physical** MDP features (excludes non-physical features, i.e., additional software related MDP features)

Physical MDP Feature:	**Description:**	**Notes:** (Assumes operation in Normal / Default Mode)
Keys	**QU/Q**	Primary qu key-value, secondary q key-value
	OF/.tv	Primary of key-value, secondary <dot>tv key-value
	OR/.info	Primary or key-value, secondary <dot>info key-value
	IN/.org	Primary in key-value, secondary <dot>org key-value
	EN/.edu	Primary en key-value, secondary <dot>edu key-value
	ES/.gov	Primary es key-value, secondary <dot>gov key-value
	RE/.mil	Primary re key-value, secondary <dot>mil key-value
	TH/www.	Primary th key-value, secondary www<dot> key-value
	AT/.co	Primary at key-value, secondary <dot>co key-value
	ED/.ac	Primary ed key-value, secondary <dot>ac key-value
	ER/.ccode	Primary er key-value, secondary user configurable URL country-code key-value
	ON/.net	Primary on key-value, secondary <dot>net key-value
	AN/.com	Primary an key-value, secondary <dot>com key-value
	SPC T/.biz	Primary <space>t key-value, secondary <dot>biz key-value
	E SPC/.pro	Primary e<space> key-value, secondary <dot>pro key-value
	DUAL	Accesses secondary key-values
	DUAL SHIFT	Accesses SHIFT equivalent of secondary key-values
	Multi DEL	User configurable left-to-right delete of up to (N characters, words, sentences or paragraphs)
	Multi BSPC	User configurable right-to-left delete of up to (N characters, words, sentences or paragraphs)
	+/-/Alt Lk	Primary +/- sign operator, secondary ALT LOCK operator
	√/Ctrl Lk	Primary Square Root operator, secondary CTRL LOCK operator
	%/Seq Lk	Primary Percentage operator, secondary Sequential Typing LOCK operator
	C/AC/Dual Lk	Primary Clear Calculator operator, secondary DUAL LOCK operator
	MKUP	Percentage Mark Up calculation operator
Buttons	Multi Press	Multi-Press mode ON/OFF (aka Toggle feature)
	Trans –	Translate Minimize (Implode)
	Trans +	Translate Maximize (Explode or Expand)
	Trans Mode	Translate mode ON/OFF (ON/OFF toggle of user configurable Automatic Translate feature)
	MR	Memory Recall
	M+	Memory Plus
	M-	Memory Minus
	MC	Memory Clear
	Calc Lock	Calculator mode ON/OFF (in combination with NUM LOCK)
LCD	LCD	Calculator LCD showing conventional calculator display characteristics (Numerics, Memory indicator, +/- sign, Error indicator etc.)

Fig. 2d

Fig 3

Country codes for the user configurable .ccode MDP key values (default value is .uk).

.ac – Ascension Island
.ad – Andorra
.ae – United Arab Emirates
.af – Afghanistan
.ag – Antigua and Barbuda
.ai – Anguilla
.al – Albania
.am – Armenia
.an – Netherlands Antilles
.ao – Angola
.aq – Antarctica
.ar – Argentina
.as – American Samoa
.at – Austria
.au – Australia
.aw – Aruba
.az – Azerbaijan
.ba – Bosnia and Herzegovina
.bb – Barbados
.bd – Bangladesh
.be – Belgium
.bf – Burkina Faso
.bg – Bulgaria
.bh – Bahrain
.bi – Burundi
.bj – Benin
.bm – Bermuda
.bn – Brunei Darussalam
.bo – Bolivia
.br – Brazil
.bs – Bahamas
.bt – Bhutan
.bv – Bouvet Island
.bw – Botswana
.by – Belarus
.bz – Belize
.ca – Canada
.cc – Cocos (Keeling) Islands
.cd – Congo, Democratic Republic of the
.cf – Central African Republic
.cg – Congo, Republic of
.ch – Switzerland
.ci – Cote d'Ivoire
.ck – Cook Islands
.cl – Chile
.cm – Cameroon
.cn – China
.co – Colombia
.cr – Costa Rica
.cu – Cuba
.cv – Cap Verde
.cx – Christmas Island
.cy – Cyprus
.cz – Czech Republic
.de – Germany
.dj – Djibouti
.dk – Denmark
.dm – Dominica
.do – Dominican Republic
.dz – Algeria
.ec – Ecuador
.ee – Estonia
.eg – Egypt
.eh – Western Sahara
.er – Eritrea
.es – Spain
.et – Ethiopia
.fi – Finland
.fj – Fiji
.fk – Falkland Islands (Malvina)
.fm – Micronesia, Federal State of
.fo – Faroe Islands
.fr – France
.ga – Gabon
.gd – Grenada
.ge – Georgia
.gf – French Guiana
.gg – Guernsey
.gh – Ghana
.gi – Gibraltar
.gl – Greenland
.gm – Gambia
.gn – Guinea
.gp – Guadeloupe
.gq – Equatorial Guinea
.gr – Greece
.gs – South Georgia & South Sandwich Islands
.gt – Guatemala
.gu – Guam
.gw – Guinea-Bissau
.gy – Guyana
.hk – Hong Kong
.hm – Heard and McDonald Islands
.hn – Honduras
.hr – Croatia/Hrvatska
.ht – Haiti
.hu – Hungary
.id – Indonesia
.ie – Ireland
.il – Israel
.im – Isle of Man
.in – India
.io – British Indian Ocean Territory
.iq – Iraq
.ir – Iran (Islamic Republic of)
.is – Iceland
.it – Italy
.je – Jersey
.jm – Jamaica
.jo – Jordan
.jp – Japan
.ke – Kenya
.kg – Kyrgyzstan
.kh – Cambodia
.ki – Kiribati
.km – Comoros
.kn – Saint Kitts and Nevis
.kp – Korea, Democratic People's Republic
.kr – Korea, Republic of
.kw – Kuwait
.ky – Cayman Islands
.kz – Kazakhstan
.la – Lao People's Democratic Republic
.lb – Lebanon
.lc – Saint Lucia
.li – Liechtenstein
.lk – Sri Lanka
.lr – Liberia
.ls – Lesotho
.lt – Lithuania
.lu – Luxembourg
.lv – Latvia
.ly – Libyan Arab Jamahiriya
.ma – Morocco
.mc – Monaco
.md – Moldova, Republic of
.mg – Madagascar
.mh – Marshall Islands
.mk – Macedonia, Former Yugoslav Republic
.ml – Mali
.mm – Myanmar
.mn – Mongolia
.mo – Macau
.mp – Northern Mariana Islands
.mq – Martinique
.mr – Mauritania
.ms – Montserrat
.mt – Malta
.mu – Mauritius
.mv – Maldives
.mw – Malawi
.mx – Mexico
.my – Malaysia
.mz – Mozambique
.na – Namibia
.nc – New Caledonia
.ne – Niger
.nf – Norfolk Island
.ng – Nigeria
.ni – Nicaragua
.nl – Netherlands
.no – Norway
.np – Nepal
.nr – Nauru
.nu – Niue
.nz – New Zealand
.om – Oman
.pa – Panama
.pe – Peru
.pf – French Polynesia
.pg – Papua New Guinea
.ph – Philippines
.pk – Pakistan
.pl – Poland
.pm – St. Pierre and Miquelon
.pn – Pitcairn Island
.pr – Puerto Rico
.ps – Palestinian Territories
.pt – Portugal
.pw – Palau
.py – Paraguay
.qa – Qatar
.re – Reunion Island
.ro – Romania
.ru – Russian Federation
.rw – Rwanda
.sa – Saudi Arabia
.sb – Solomon Islands
.sc – Seychelles
.sd – Sudan
.se – Sweden
.sg – Singapore
.sh – St. Helena
.si – Slovenia
.sj – Svalbard and Jan Mayen Islands
.sk – Slovak Republic
.sl – Sierra Leone
.sm – San Marino
.sn – Senegal
.so – Somalia
.sr – Suriname
.st – Sao Tome and Principe
.sv – El Salvador
.sy – Syrian Arab Republic
.sz – Swaziland
.tc – Turks and Caicos Islands
.td – Chad
.tf – French Southern Territories
.tg – Togo
.th – Thailand
.tj – Tajikistan
.tk – Tokelau
.tm – Turkmenistan
.tn – Tunisia
.to – Tonga
.tp – East Timor
.tr – Turkey
.tt – Trinidad and Tobago
.tv – Tuvalu
.tw – Taiwan
.tz – Tanzania
.ua – Ukraine
.ug – Uganda
.uk – United Kingdom
.um – US Minor Outlying Islands
.us – United States
.uy – Uruguay
.uz – Uzbekistan
.va – Holy See (City Vatican State)
.vc – Saint Vincent and the Grenadines
.ve – Venezuela
.vg – Virgin Islands (British)
.vi – Virgin Islands (USA)
.vn – Vietnam
.vu – Vanuatu
.wf – Wallis and Futuna Islands
.ws – Western Samoa
.ye – Yemen
.yt – Mayotte
.yu – Yugoslavia
.za – South Africa
.zm – Zambia
.zw – Zimbabwe

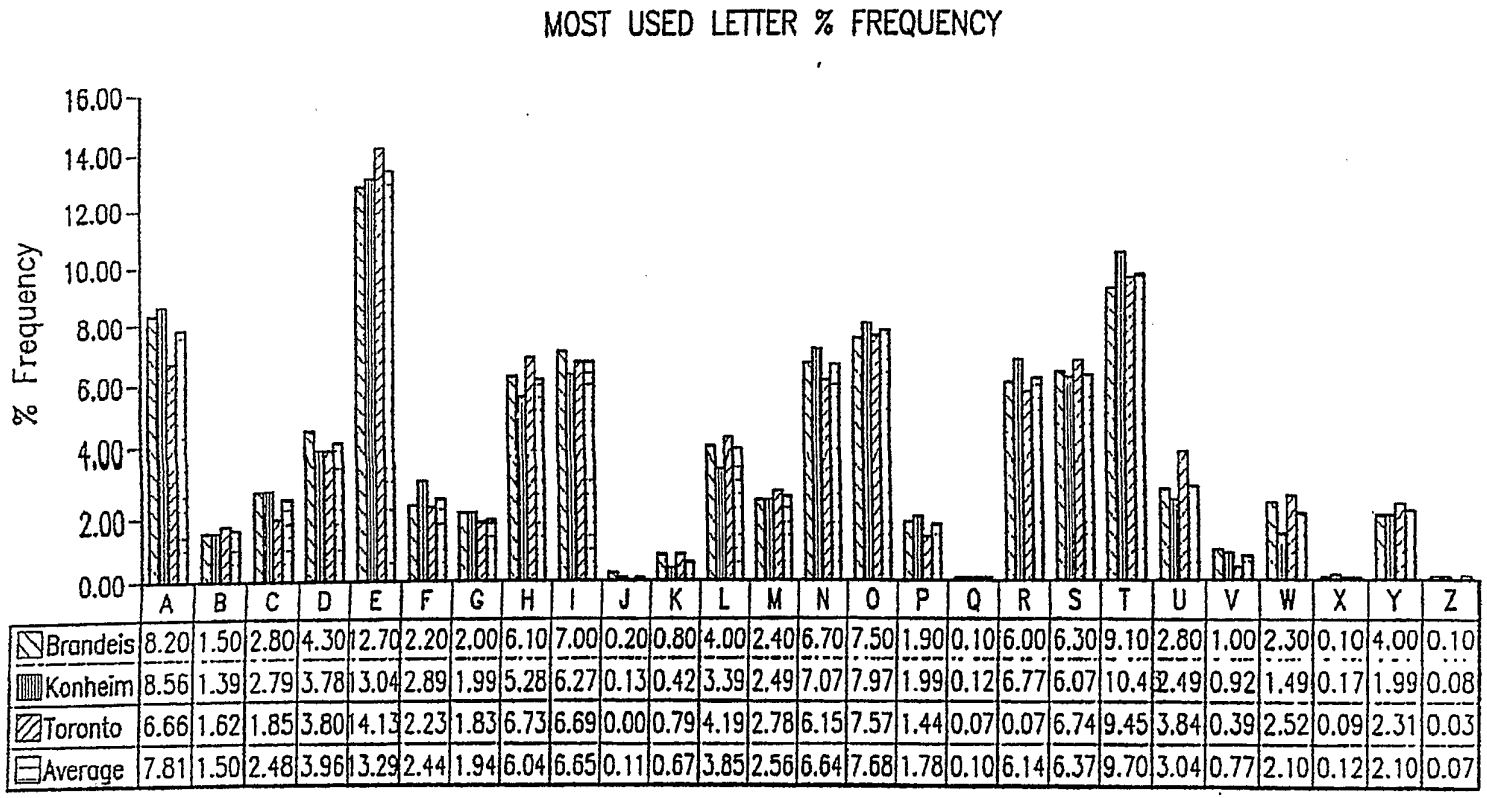
Example 1: When I wish to type **www.bbc.co.uk** I can do it using the following keystrokes:				
Stroke: 1	+2	3 4 5	6 +7	8 +9
Key:	DUAL+TH/www.	b b c	DUAL+AT/.co.	DUAL+ER/.ccode
Value:	**www.**	**b b c**	**.co**	**.uk**
Screen: **www.bbc.co.uk**				
Example 2: When I wish to type **www.dti.gov.uk** I can do it using the following keystrokes:				
Stroke: 1	+2	3 4 5	6 +7	8 +9
Key:	DUAL+TH/www.	d t i	DUAL+ES/.gov	DUAL+ER/.ccode
Value:	**www.**	**d t i**	**.gov**	**.uk**
Screen: **www.dti.gov.uk**				
Example 3: When I wish to type **www.ox.ac.uk** I can do it using the following keystrokes:				
Stroke: 1	+2	3 4	5 +6	7 +8
Key:	DUAL+TH/www.	o x	DUAL+ED/.ac	DUAL+ER/.ccode
Value:	**www.**	**o x**	**.ac**	**.uk**
Screen: **www.ox.ac.uk**				

Fig 4

The above MDP-keys permit Entity deletions of N characters, N words, N sentences or N paragraphs as configured by the user during installation or run-time configuration.

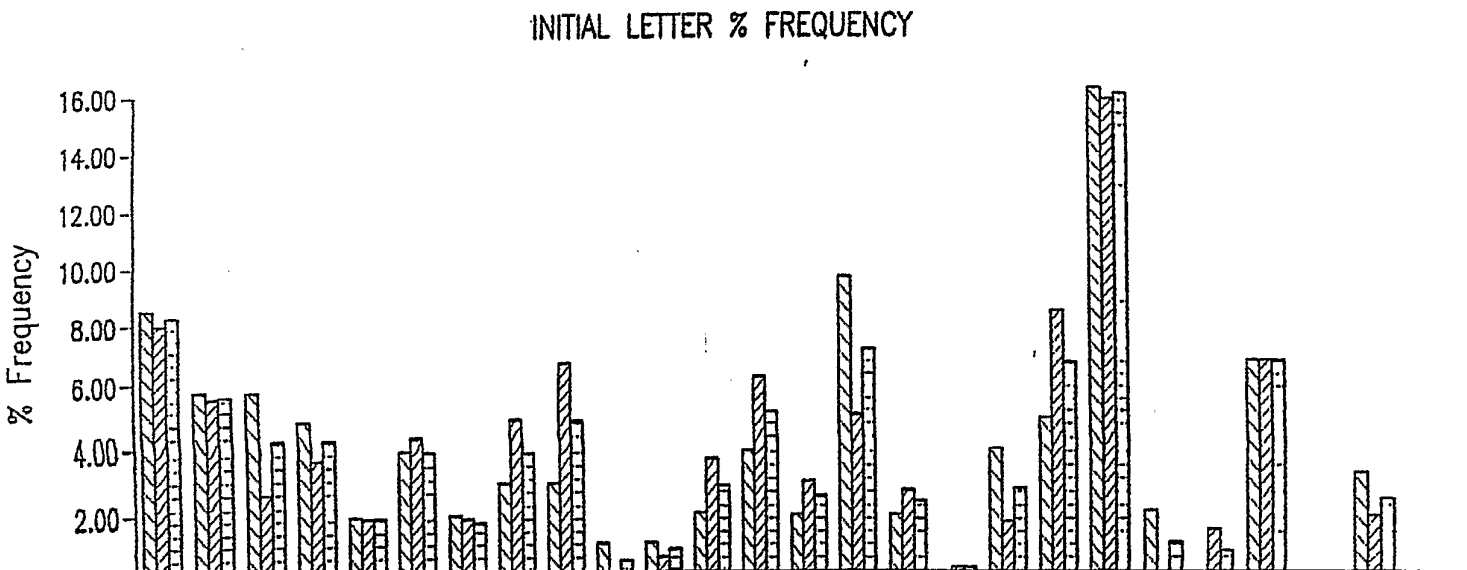
Entity:	**Basic Delimiters include:**	**Min N:**	**Max N:**
Characters	N/A	2	16
Words	Space, or White-Space, or combination thereof	1	8
Sentences	Full-stop, or Full-Stop then Space, or Full-Stop then White-Space, or combination thereof	1	4
Paragraphs	Full-Stop then New-Line, or More than 1 New-Line, or combination thereof	1	2

Fig. 5



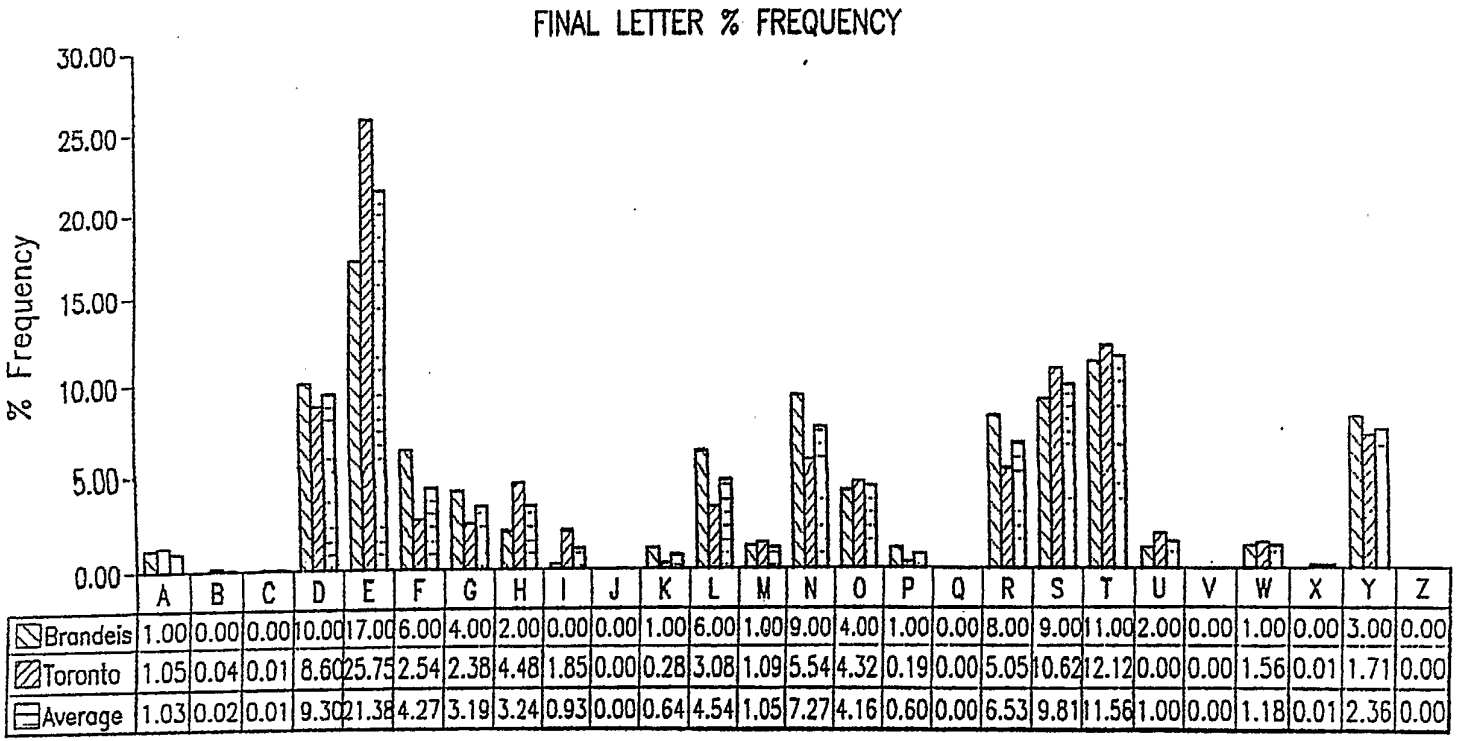
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Brandeis	8.20	1.50	2.80	4.30	2.70	2.20	2.00	6.10	7.00	0.20	0.80	4.00	2.40	6.70	7.50	1.90	0.10	6.00	6.30	9.10	2.80	1.00	2.30	0.10	4.00	0.10
Konheim	8.56	1.39	2.79	3.78	3.04	2.89	1.99	5.28	6.27	0.13	0.42	3.39	2.49	7.07	7.97	1.99	0.12	6.77	6.07	10.4	2.49	0.92	1.49	0.17	1.99	0.08
Toronto	6.66	1.62	1.85	3.80	4.13	2.23	1.83	6.73	6.69	0.00	0.79	4.19	2.78	6.15	7.57	1.44	0.07	0.07	6.74	9.45	3.84	0.39	2.52	0.09	2.31	0.03
Average	7.81	1.50	2.48	3.96	3.29	2.44	1.94	6.04	6.65	0.11	0.67	3.85	2.56	6.64	7.68	1.78	0.10	6.14	6.37	9.70	3.04	0.77	2.10	0.12	2.10	0.07

Fig. 6a



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Brandeis	9.00	6.00	6.00	5.00	2.00	4.00	2.00	3.00	3.00	1.00	1.00	2.00	4.00	2.00	10.00	2.00	0.00	4.00	5.00	17.00	2.00	0.00	7.00	0.00	3.00	0.00
Toronto	8.45	5.77	2.71	3.82	1.97	4.42	1.80	4.93	6.89	0.00	0.58	3.72	6.46	2.97	5.05	2.77	0.15	1.59	8.78	16.46	0.00	1.44	7.00	0.00	1.71	0.00
Average	8.73	5.89	4.36	4.41	1.99	4.21	1.90	3.97	4.95	0.50	0.79	2.86	5.23	2.49	7.53	2.39	0.08	2.80	6.89	16.73	1.00	0.72	7.00	0.00	2.36	0.00

Fig. 6b



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Brandeis	1.00	0.00	0.00	10.00	17.00	6.00	4.00	2.00	0.00	0.00	1.00	6.00	1.00	9.00	4.00	1.00	0.00	8.00	9.00	11.00	2.00	0.00	1.00	0.00	3.00	0.00
Toronto	1.05	0.04	0.01	8.60	25.75	2.54	2.38	4.48	1.85	0.00	0.28	3.08	1.09	5.54	4.32	0.19	0.00	5.05	10.62	12.12	0.00	0.00	1.56	0.01	1.71	0.00
Average	1.03	0.02	0.01	9.30	21.38	4.27	3.19	3.24	0.93	0.00	0.64	4.54	1.05	7.27	4.16	0.60	0.00	6.53	9.81	11.56	1.00	0.00	1.18	0.01	2.36	0.00

Fig. 6c

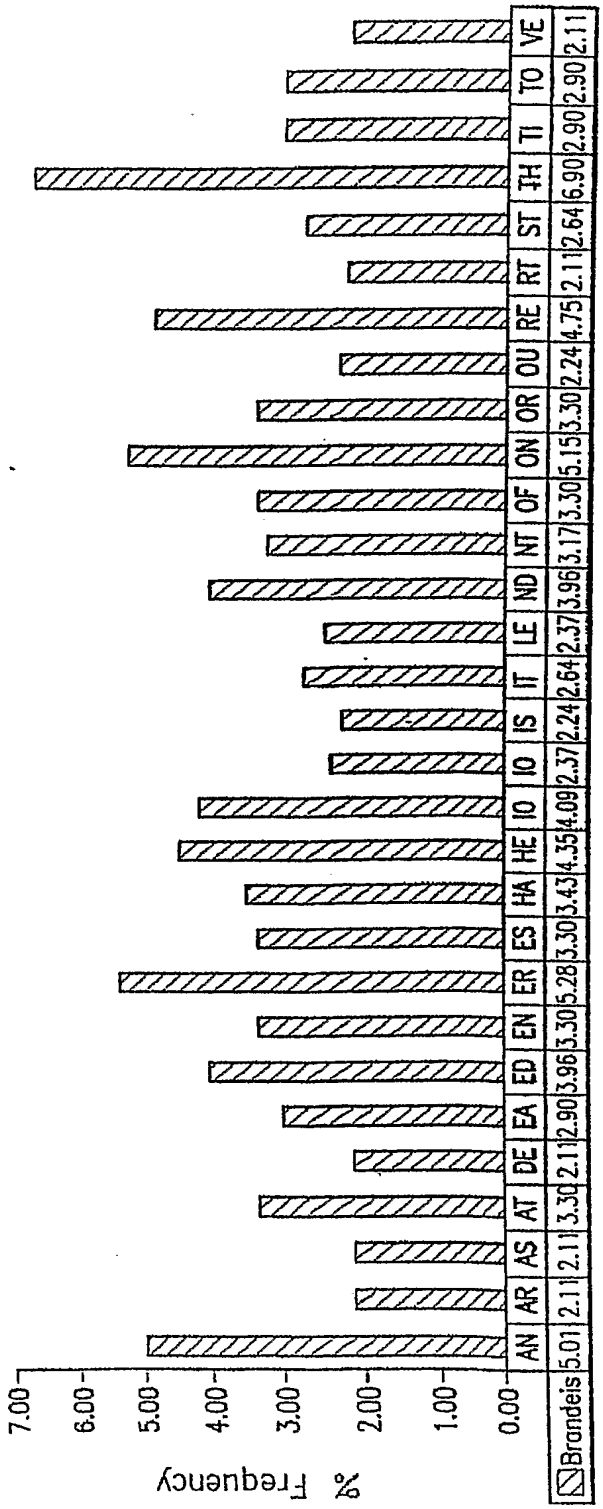

DIGRAPAH % FREQUENCY
% Frequency
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Brandeis
AN 5.01
AR 2.11
AS 2.11
AT 3.30
DE 2.11
EA 2.90
ED 3.96
EN 3.30
ER 5.28
ES 3.30
HA 3.43
HE 4.35
IO 4.09
IO 2.37
IS 2.24
IT 2.64
LE 2.37
ND 3.96
NT 3.17
OF 3.30
ON 5.15
OR 3.30
OU 2.24
RE 4.75
RT 2.11
ST 2.64
TH 6.90
TI 2.90
TO 2.90
VE 2.11

Fig. 6d

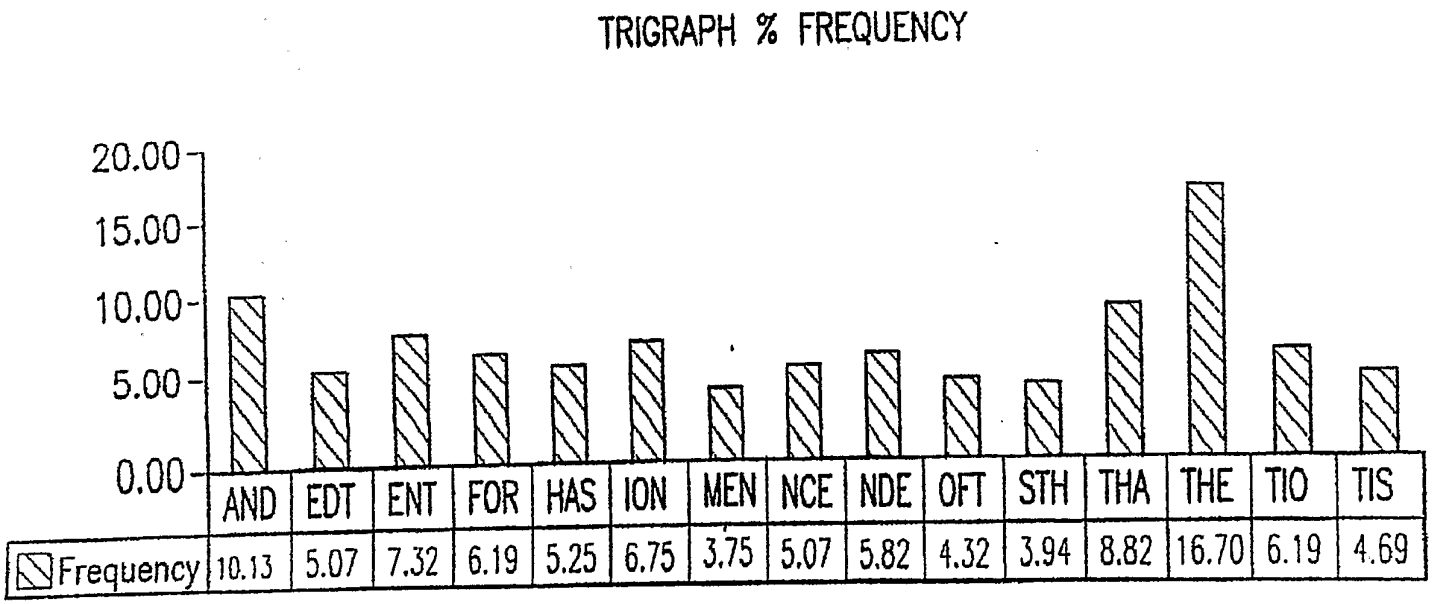

TRIGRAPH % FREQUENCY
20.00
15.00
10.00
5.00
0.00
AND EDT ENT FOR HAS ION MEN NCE NDE OFT STH THA THE TIO TIS
Frequency 10.13 5.07 7.32 6.19 5.25 6.75 3.75 5.07 5.82 4.32 3.94 8.82 16.70 6.19 4.69

Fig. 6e

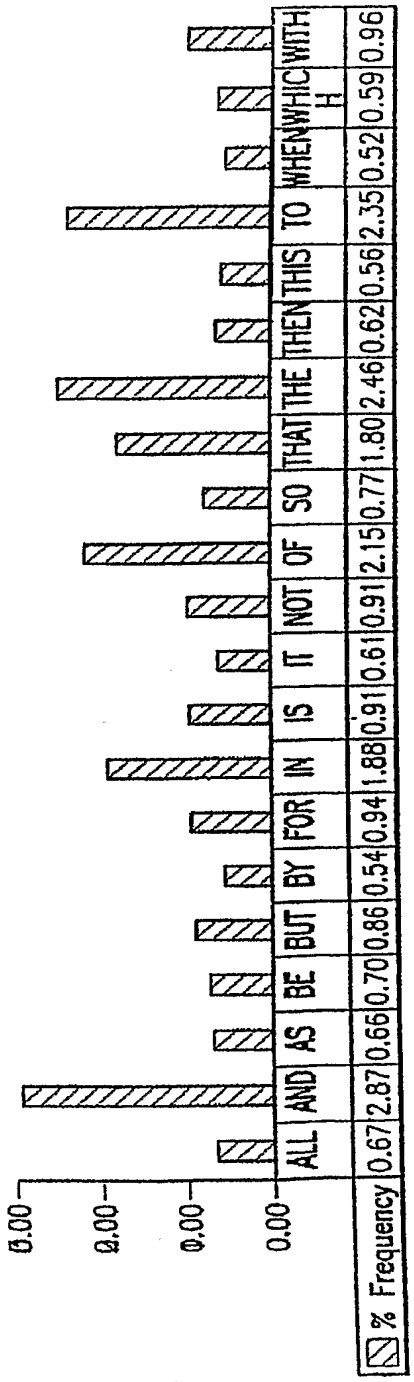

MOST WORD % FREQUENCY
0.00
0.00
0.00
0.00
% Frequency
ALL 0.67
AND 2.87
AS 0.66
BE 0.70
BUT 0.86
BY 0.54
FOR 0.94
IN 1.88
IS 0.91
IT 0.61
NOT 0.91
OF 2.15
SO 0.77
THAT 1.80
THE 2.46
THEN 0.62
THIS 0.56
TO 2.35
WHEN 0.52
WHICH 0.59
WITH 0.96

Fig. 6f

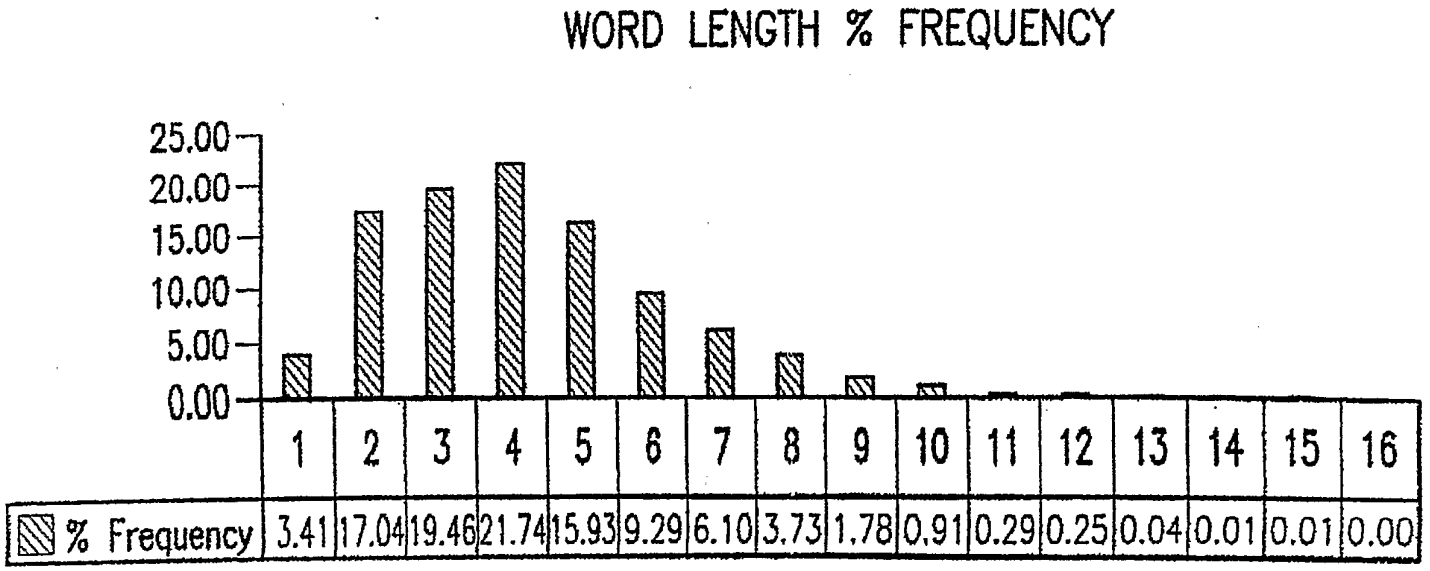
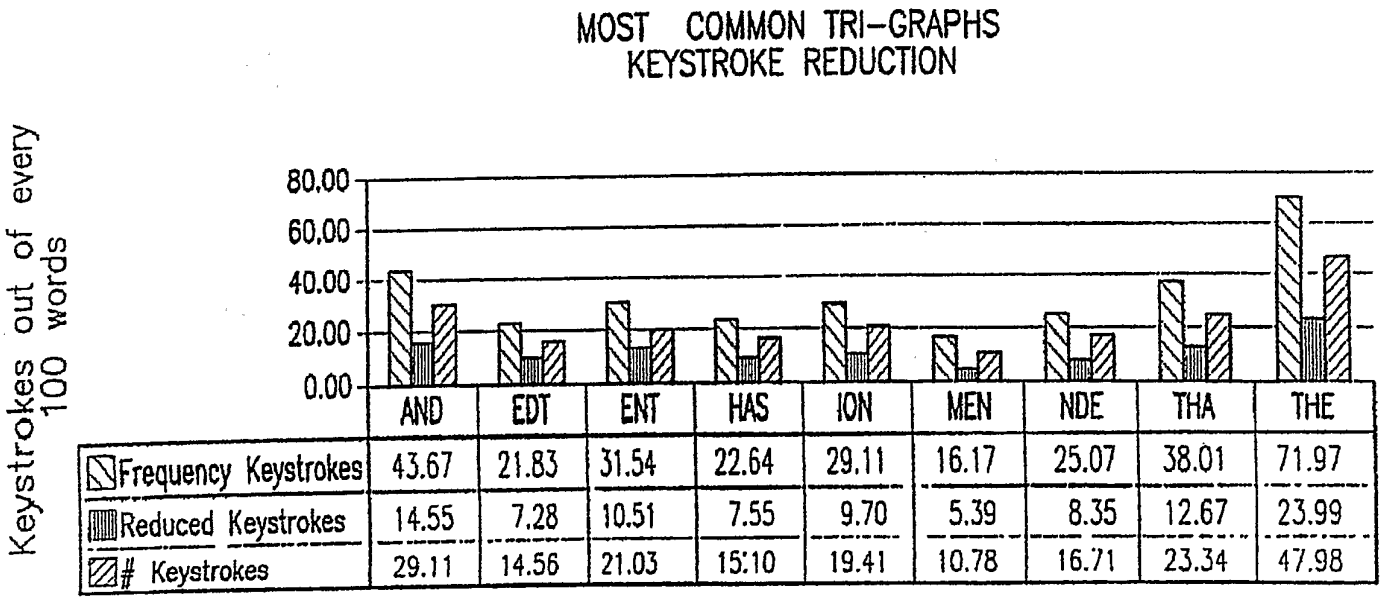

WORD LENGTH % FREQUENCY
25.00
20.00
15.00
10.00
5.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
% Frequency
3.41 17.04 19.46 21.74 15.93 9.29 6.10 3.73 1.78 0.91 0.29 0.25 0.04 0.01 0.01 0.00

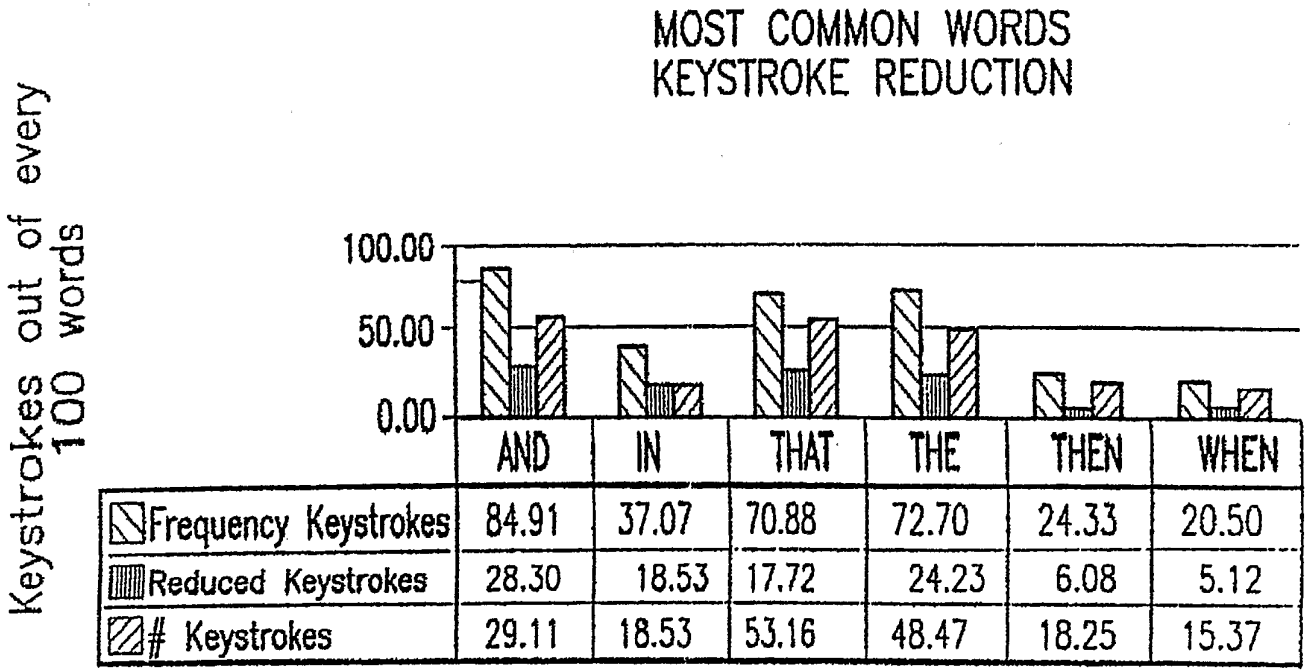
Fig. 6g



	AND	EDT	ENT	HAS	ION	MEN	NDE	THA	THE
Frequency Keystrokes	43.67	21.83	31.54	22.64	29.11	16.17	25.07	38.01	71.97
Reduced Keystrokes	14.55	7.28	10.51	7.55	9.70	5.39	8.35	12.67	23.99
# Keystrokes	29.11	14.56	21.03	15.10	19.41	10.78	16.71	23.34	47.98

Fig. 6h

14/26



	AND	IN	THAT	THE	THEN	WHEN
Frequency Keystrokes	84.91	37.07	70.88	72.70	24.33	20.50
Reduced Keystrokes	28.30	18.53	17.72	24.23	6.08	5.12
# Keystrokes	29.11	18.53	53.16	48.47	18.25	15.37

Fig. 6i

	Normal Mode			Caps Lock Mode		
	Letter Key (t,T)	Symbol Key (3,#)	Feature Key (th, TH , www,)	Letter Key (T,t)	Symbol Key (3,#)	Feature Key (TH, th, WWW,)
Normal	t	3	th	T	3	TH
Shift	T	#	TH	t	#	th
Dual	T	#	www.	t	#	WWW.
Dual Shift	T	#	WWW.	t	#	www.

Fig 7a

	Normal Mode			Caps Lock Mode		
	Letter Key (t,T,the)	Letter Key (qu,QU,q)	Feature Key (th,TH,www)	Letter Key (T,t,THE)	Letter Key (QU,qu,Q)	Feature Key (th, TH , WW)W.)
Normal Mode	t	qu	th	T	QU	TH
Shift	T	QU	TH	t	qu	th
Dual	the	q	www	THE	Q	WWW
Dual Shift	THE	Q	WWW	the	q	www

Fig 7b

	NORMAL MODE:		MDP KEYING:	
KEY:	Default	Shift	Dual	Dual Shift
OF .tv	of	OF	.tv	.TV
ED .ac.	ed	ED	.ac.	.AC.
ON .net	on	ON	.net	.NET
EN .edu	en	EN	.edu	.EDU
ES .gov	es	ES	.gov	.GOV
RE .mil	re	RE	.mil	.MIL
TH www.	th	TH	www.	WWW.
AT .co.	at	AT	.co.	.CO.
OR .info	or	OR	.info	.INFO
AN .com	an	AN	.com	.COM
IN .org	in	IN	.org	.ORG
ER .ccode	er	ER	.<ccode>	.<CCODE>
SPC T .biz	<space>t	<space>T	.biz	.BIZ
E SPC .pro	e<space>	E<space>	.pro	.PRO
QU q	qu	QU	q	Q
W	w	W	W	W
E	e	E	E	E
R	r	R	R	R
T	t	T	T	T
Y	y	Y	Y	Y
U	u	U	U	U
I	i	I	I	I
O	o	O	O	O
P	p	P	P	P
A	a	A	A	A
S	s	S	S	S
D	d	D	D	D
F	f	F	F	F
G	g	G	G	G
H	h	H	H	H
J	j	J	J	J
K	k	K	K	K
L	l	L	L	L
Z	z	Z	Z	Z
X	x	X	X	X
C	c	C	C	C
V	v	V	V	V
B	b	B	B	B
N	n	N	N	N
M	m	M	M	M
' ¬ `	'	¬ ¦ "	¬ ¦ "	¬ ¦ "
1 !	1	!	!	!
2 "	2	" £	" £	" £
3 £	3	£ $	£ $	£ $
4 $	4	$ %	$ %	$ %
5 %	5	% ^	% ^	% ^
6 ^	6	^ &	^ &	^ &
7 &	7	& *	& *	& *
8 *	8	* (	* (	* (
9 (	9	( )	( )	( )
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] }	]	} :	} :	} :
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, <	,	~ <	~ <	~ <
. >	.	< >	< >	< >
/ ?	/	> ?	> ?	> ?
\ |	\	? |	? |	? |
/ *	/	| /	| /	| /
-	*	/ *	/ *	/ *
+	-	* -	* -	* -
	+	- +	- +	- +

MDP Composite Typing in NORMAL Mode

Fig 7c

	CAPS LOCK MODE:		MDP KEYING:	
KEY:	Default	Shift	Dual	Dual Shift
OF .tv	OF	of	.TV	.tv
ED .ac.	ED	ed	.AC.	.ac.
ON .net	ON	on	.NET	.net
EN .edu	EN	en	.EDU	.edu
ES .gov	ES	es	.GOV	.gov
RE .mil	RE	re	.MIL	.mil
TH www.	TH	th	WWW.	www.
AT .co.	AT	at	.CO.	.co.
OR .info	OR	or	.INFO	.info
AN .com	AN	an	.COM	.com
IN .org	IN	in	.ORG	.org
ER .ccode	ER	er	.<CCODE>	.<ccode>
SPC T .biz	<space>T	<space>t	.BIZ	.biz
E SPC .pro	E<space>	e<space>	.PRO	.pro
QU q	QU	qu	Q	q
W	W	w	w	w
E	E	e	e	e
R	R	r	r	r
T	T	t	t	t
Y	Y	y	y	y
U	U	u	u	u
I	I	i	i	i
O	O	o	o	o
P	P	p	p	p
A	A	a	a	a
S	S	s	s	s
D	D	d	d	d
F	F	f	f	f
G	G	g	g	g
H	H	h	h	h
J	J	j	j	j
K	K	k	k	k
L	L	l	l	l
Z	Z	z	z	z
X	X	x	x	x
C	C	c	c	c
V	V	v	v	v
B	B	b	b	b
N	N	n	n	n
M	M	m	m	m
` ¬ `	`	¬	¬	¬
1 !	1	!	!	!
2 "	2	"	"	"
3 £	3	£	£	£
4 $	4	$	$	$
5 %	5	%	%	%
6 ^	6	^	^	^
7 &	7	&	&	&
8 *	8	*	*	*
9 (	9	(	(	(
0)	0	)	)	)
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= +	=	+	+	+
TAB	TAB	BACKTAB	BACKTAB	BACKTAB
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] }	]	}	}	}
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' @	'	@	@	@
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. >	.	>	>	>
/ ?	/	?	?	?
\ |	\	|	|	|
/	/	/	/	/
*	*	*	*	*
-	-	-	-	-
+	+	+	+	+

MDP Composite Typing in CAPS LOCK Mode

Fig. 7d.

	DUAL LOCK MODE:		MDP KEYING:	
KEY:	Default	Shift	Dual	Dual Shift
OF .tv	.tv	.TV	of	OF
ED .ac.	.ac.	.AC.	ed	ED
ON .net	.net	.NET	on	ON
EN .edu	.edu	.EDU	en	EN
ES .gov	.gov	.GOV	es	ES
RE .mil	.mil	.MIL	re	RE
TH www.	www.	WWW.	th	TH
AT .co.	.co.	.CO.	at	AT
OR .info	.info	.INFO	or	OR
AN .com	.com	.COM	an	AN
IN .org	.org	.ORG	in	IN
ER .ccode	.<ccode>	.<CCODE>	er	ER
SPC T .biz	.biz	.BIZ	<space>t	<space>T
E SPC .pro	.pro	.PRO	e<space>	E<space>
QU q	q	Q	qu	QU
W	w	W	W	W
E	e	E	E	E
R	r	R	R	R
T	t	T	T	T
Y	y	Y	Y	Y
U	u	U	U	U
I	i	I	I	I
O	o	O	O	O
P	p	P	P	P
A	a	A	A	A
S	s	S	S	S
D	d	D	D	D
F	f	F	F	F
G	g	G	G	G
H	h	H	H	H
J	j	J	J	J
K	k	K	K	K
L	l	L	L	L
Z	z	Z	Z	Z
X	x	X	X	X
C	c	C	C	C
V	v	V	V	V
B	b	B	B	B
N	n	N	N	N
M	m	M	M	M
` ¬ `	`	¬	¬	¬
1 !	1	!	!	!
2 "	2	"	"	"
3 £	3	£	£	£
4 $	4	$	$	$
5 %	5	%	%	%
6 ^	6	^	^	^
7 &	7	&	&	&
8 *	8	*	*	*
9 (	9	(	(	(
0)	0	)	)	)
- _	-	_	_	_
= +	=	+	+	+
TAB	TAB	BACKTAB	BACKTAB	BACKTAB
[{	[	{	{	{
] }	]	}	}	}
; :	;	:	:	:
' @	'	@	@	@
# ~	#	~	~	~
, <	,	<	<	<
. >	.	>	>	>
/ ?	/	?	?	?
\ |	\	|	|	|
/	/	/	/	/
*	*	*	*	*
-	-	-	-	-
+	+	+	+	+

MDP Composite Typing in DUAL LOCK Mode

Fig. 7e

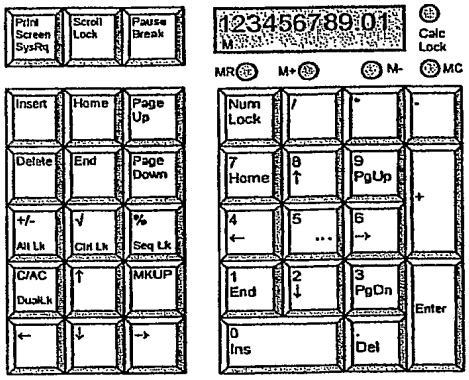


Fig 8a

CALC LK:	NUM LK:	Calculator LCD is:	Action:
ON	OFF	ON	Performs calculator operations / functions on keyboard alone without relaying them to computer.
ON	ON	ON	Performs calculator operations / functions on keyboard and relays them to computer.
OFF	OFF	OFF	Relays special characters (Dual Lock, Alt Lock, Ctrl Lock, Seq Lock etc.) and 2nd key values (Home, PgUp, End, PgDn, Ins, Del etc.) to computer only.
OFF	ON	OFF	Does NOT perform calculator operations / functions on keyboard but relays them to computer (just like a regular / conventional keyboard).

Fig 8b

ENGLISH Language Component Breakdowns and Order of Frequencies:

Order Of Frequency Of Single Letters	E N A S R I U T O L D C M P V F B G X H Q Y Z J K W
Order Of Frequency Of Digraphs	**th er on an re** he **in ed** nd ha **at en es of or** nt ea ti to it st io le is ou ar as de rt ve
Order Of Frequency Of Trigraphs	the and tha ent ion tio for nde has nce edt tis oft sth men
Order Of Frequency Of Most Common Doubles	ss ee tt ff ll mm oo
Order Of Frequency Of Initial Letters	<space>T O A W B C D S F M R H I Y E G L N P U J K
Order Of Frequency Of Final Letters	E<space> S T D N R Y F L O G H A K M P U W
One-Letter Words	A, I.
Most Frequent Two-Letter Words	of to in it is be as at so we he by or on do if me my up an go no us am
Most Frequent Three-Letter Words	the and for are but not you all any can had her was one our out day get has him his how man new now old see two way who boy did its let put say she too use
Most Frequent Four-Letter Words	that with have this will your from they know want been good much some time

FRENCH Language Component Breakdowns and Order of Frequencies:

Order Of Frequency Of Single Letters	E N A S R I U T O L D C M P V F B G X H Q Y Z J K W
Most Common Digraphs	**es en** nt **re on le ou de se an te ai** er ne **em** ed **ar ce** me it et ie ti el ns ur
Most Common Trigraphs	ede les lle que ait eme ion eur ell sse est dan del men des tio ese ans ter ons qui ais ous ent
Most Frequent Doubles	ss ll ee nn tt ff cc rr mm pp
One-Letter Words	a, y, o
Most Common Two-Letter Words	au ce ci de du en et il je la le ma me ne ni on ou sa se si un

GERMAN Language Component Breakdowns and Order of Frequencies:

Order Of Frequency Of Single Letters	E N R I S T U D A H G L O C M B Z F W K V P J Q X Y
Most Common Digraphs	**en ch er ei te ie** de **ge es** in **ne st un re be an** el di ue se au he it ri tz
Most Common Trigraphs	ein ich den der ten cht sch che die ung gen und nen des ben rch
Most Frequent Doubles	ee tt ll ss dd mm nn
Most Common Two-Letter Words	ab am an da er es ob so wo im in um zu du ja ab

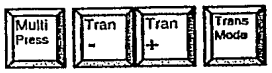
ITALIAN Language Component Breakdowns and Order of Frequencies:

Order Of Frequency Of Single Letters	E I A O R L N T S C D P U M G V H Z B F Q J K W X Y
Most Common Digraphs	**er en** re **el an on la nt es di** ti si **al de ra** co **ta to** le li in io ar or
Most Common Trigraphs	che ere zio del que ari ato eco edi ide esi idi ero par nte sta men
Most Frequent Doubles	ll ss tt ee pp nn bb gg cc
One-Letter Words	e a i o
Most Common Two-Letter Words	di in ha ho

SPANISH Language Component Breakdowns and Order of Frequencies:

Order Of Frequency Of Single Letters	E A O S R I N L D C T U P M Y Q G B H F V J Z K W X
Most Common Digraphs	**es en el de la os ar ue ra re er** as on st **ad** ai or ta co **se** ac ec ci ia
Most Common Trigraphs	que est ara ado aqu del cio nte osa ede per ist nei res sde
Most Frequent Doubles	ee ll rr aa ss cc dd nn
One-Letter Words	a e o u y
Most Common Two-Letter Words	en la de lo el se

Fig. 9



As Keys

OR

As Buttons

Multi-Press (or Toggle), **Translate–** (Minimize or Implode), **Translate+** (Maximize or Explode) MDP-keys, and **Trans-Mode** keys or buttons

Phrase:	**Dictionary Type:**	**Translate–**	**Translate+**	***Notes:***
ruf2c	SMS Texting	ruf2c	are you free to chat	*Maximize effect*
as soon as possible	Abbreviation	asap	as soon as possible	*Minimize effect*
dog	English-French	dog	chien	*Language verbatim translation*
keyboard	Dictionary	keyboard	n. A set of keys, as on a computer terminal, word processor, typewriter, or piano	*Normal dictionary providing meaning of words etc.*
water + carbon dioxide	Chemical	h2o + co2	water + carbon dioxide	*Science oriented*
gizsum wadda mate	User Defined	gizsum wadda mate	give me some water please	*Habitual or behavioural*

Fig 10a

Mnemonic	**Mnemonic Length**	**Frequency**	**Description**	**Description Length**	**Indicator Type / Flag**
Primary Key	*2nd Key*	*2nd Key*			
Char (24)	Unsigned Char	Unsigned Long	Char (64) NULL	Unsigned Char	Char

Dictionary Database Definition / Representation

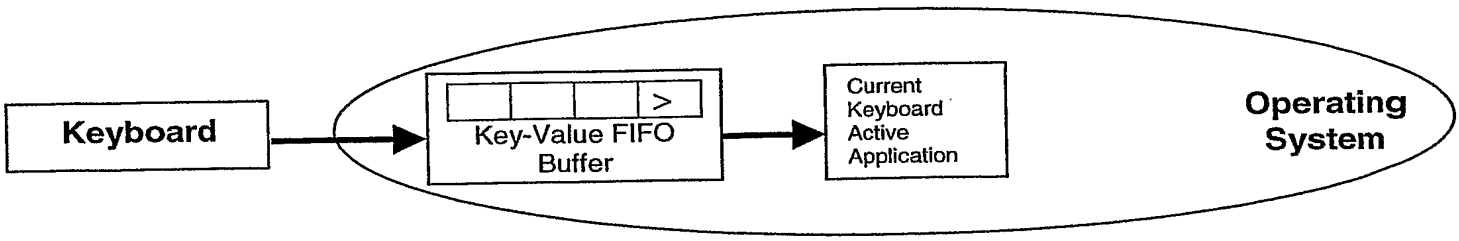
Dictionaries (run-time user configurable and downloadable from the Internet in real-time)

Mnemonic – the succinct representation of Description.
Mnemonic Length – the number of characters or length of Mnemonic.
Frequency – the count or number of times used respective of Mnemonic.
Description – the elaborate / alternative representation of Mnemonic.
Description Length – the number of characters or length of Description.
Indicator Flag / Type – see below.

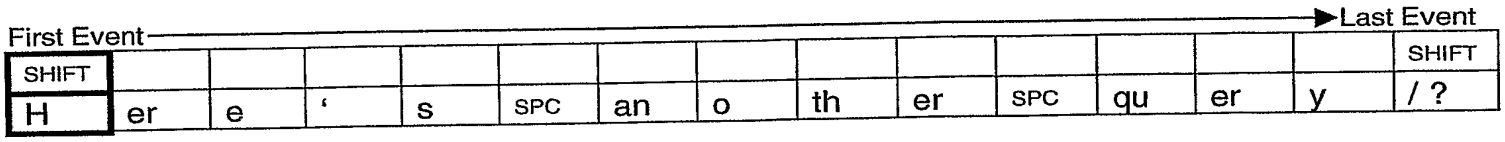
Flag / Type:	**Description:**	**Translate:**
A	Abbreviation – Mnemonic is abbreviation of its Description.	Yes
W	Word – Mnemonic is same as its Description.	Not Applicable
T	Translation – Mnemonic is verbatim word / phrase of its Description in another Language (English-French)	Yes
D	Dictionary – Mnemonic is a word. Description is its meaning as found in common language dictionary.	Yes
U	User Defined – Dictionary content is user defined and dynamic.	Yes
S	Specialized – Dictionary is designed for particular needs / environment.	Yes

Fig 10b

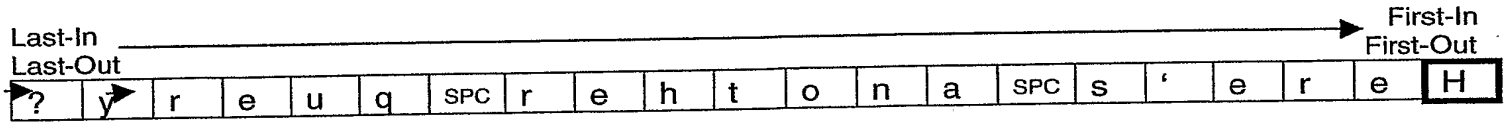
Key buffering and FIFO methodology.



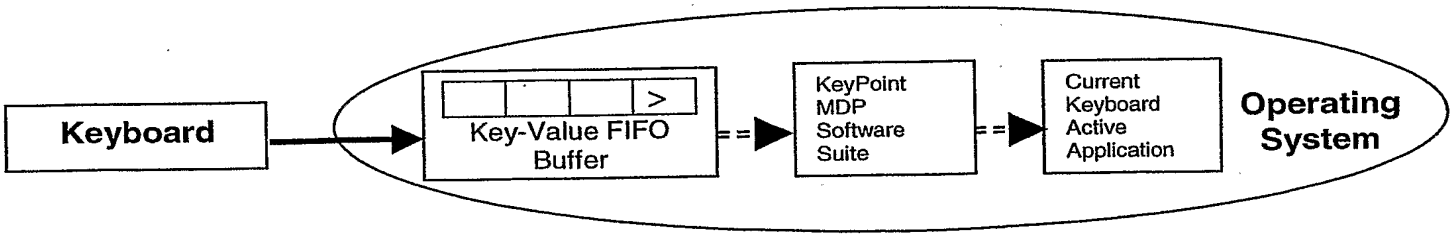
Operating Scenario for Key-Value FIFO Buffer



Order of Key-Press Events for Typing Sequence "Here's another query?"



Conversion / Mapping of Key-Press Events to Buffered FIFO Transmission



Piped Dual Channel Mode for Key-Value FIFO Buffer

Fig 11.

QWERTY	DVORAK DUAL	DVORAK LEFT	DVORAK RIGHT	MALTRON
OF .tv	OF .tv	OF .tv	OF .tv	OF .tv
ED .ac.	ED .ac.	ED .ac.	ED .ac.	ED .ac.
ON .net	ON .net	ON .net	ON .net	ON .net
EN .edu	EN .edu	EN .edu	EN .edu	EN .edu
ES .gov	ES .gov	ES .gov	ES .gov	ES .gov
RE .mil	RE .mil	RE .mil	RE .mil	RE .mil
TH www.	TH www.	TH www.	TH www.	TH www.
AT .co.	AT .co.	AT .co.	AT .co.	AT .co.
OR .info	OR .info	OR .info	OR .info	OR .info
AN .com	AN .com	AN .com	AN .com	AN .com
IN .org	IN .org	IN .org	IN .org	IN .org
ER .ccode	ER .ccode	ER .ccode	ER .ccode	ER .ccode
SPC T .biz	SPC T .biz	SPC T .biz	SPC T .biz	SPC T .biz
E SPC .pro	E SPC .pro	E SPC .pro	E SPC .pro	E SPC .pro
QU q	' @	; :	5 %	QU Q
W	. <	QU Q	6 ^	P
E	. >	B	QU Q	Y
R	P	Y	. >	C
T	Y	U	O	B
Y	F	R	R	V
U	G	S	S	M
I	C	O	U	U
O	R	. >	Y	Z
P	L	6 ^	B	L
A	A	- _	7 &	A
S	O	K	8 *	N
D	E	C	Z	I
F	U	D	A	S
G	I	T	E	F
H	D	H	H	D
J	H	E	T	T
K	T	A	D	H
L	N	Z	C	O
Z	; :	' @	9 (	,
X	QU Q	X	0)	. ?
C	J	G	X	J
V	K	V	. <	G
B	X	W	I	" '
N	B	N	N	\ _
M	M	I	W	W
` ~ `	` ~ `	` ~ `	` ~ `	` ~ `
1 !	1 !	[{	1 !	1 +
2 "	2 "	] }	2 "	2 ^
3 £	3 £	/ ?	3 £	3 £
4 $	4 $	P	4 $	4 $
5 %	5 %	F	J	5 (
6 ^	6 ^	M	L	6)
7 &	7 &	L	M	7 &
8 *	8 *	J	F	8 @
9 (	9 (	4 $	P	9 %
0)	0)	3 £	/ ?	0 =
- _	[{	2 "	[{	{ <
= +	] }	1 !	] }	} >
TAB	TAB	TAB	TAB	TAB
[{	/ ?	5 %	: :	ESC
] }	= +	= +	= +	['
: :	S	8 *	K	R
' @	- _	7 &	- _	: : '
# ~	# ~	# ~	# ~	] '
, <	W	, <	V	K
. >	V	0)	G	-
/ ?	Z	9 (	' @	X
\ |	\ |	\ |	\ |	\ |

Key Mappings between QWERTY, DVORAK (Various) and MALTRON

Fig 12

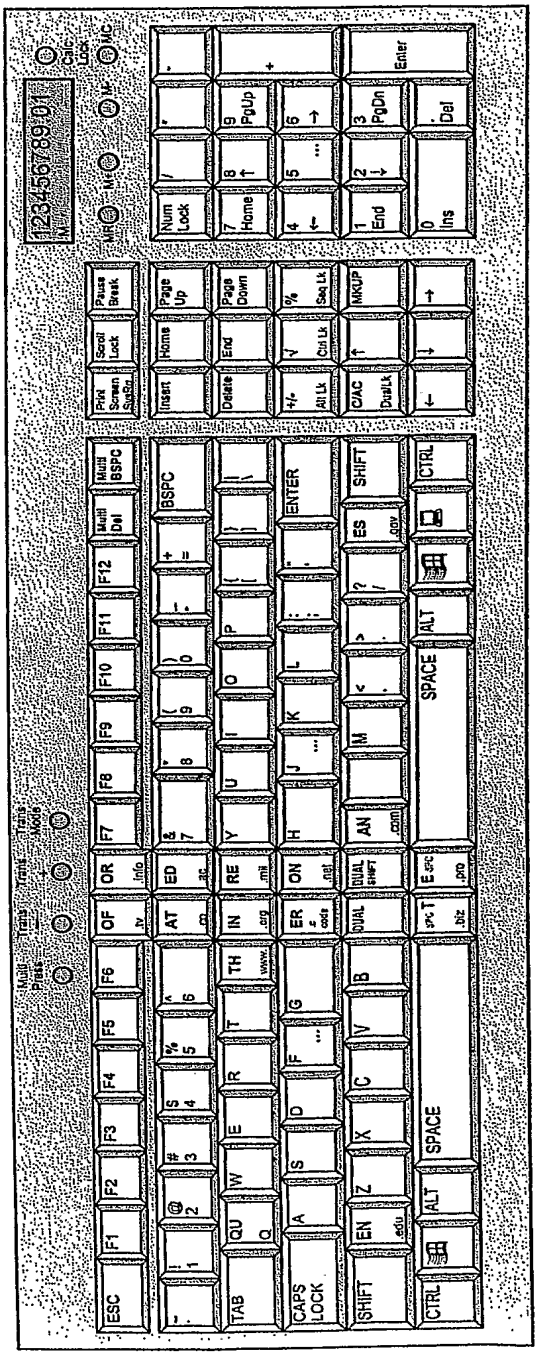


Fig 13a

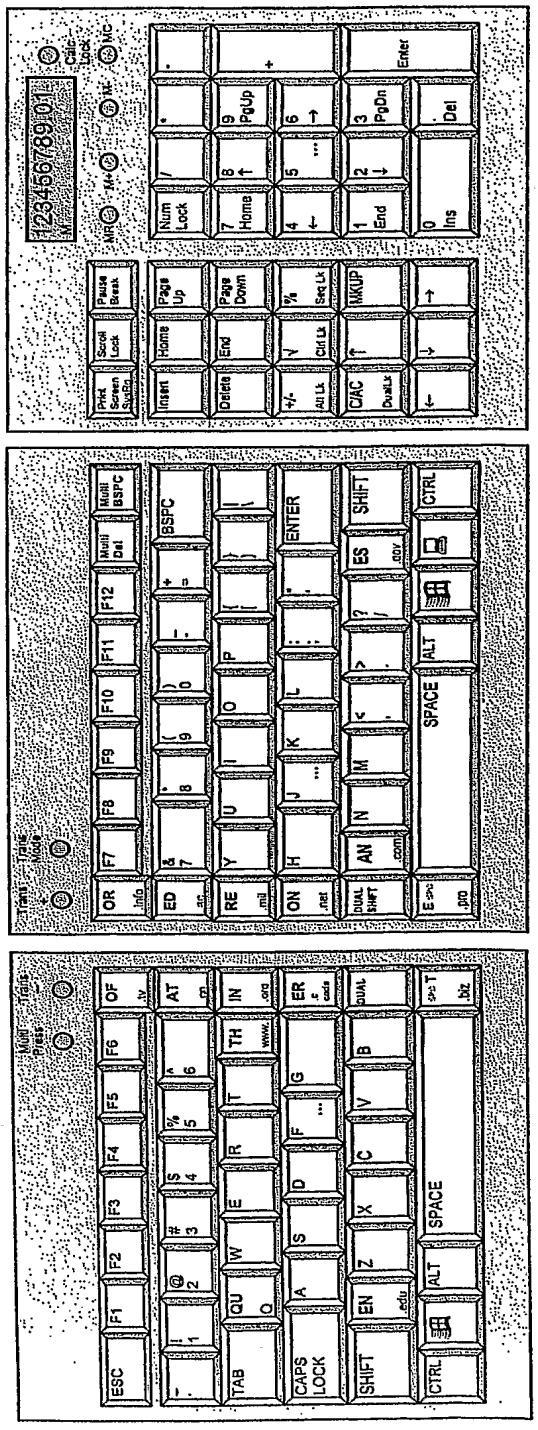

ESC
TAB
CAPS LOCK
SHIFT
CTRL
ALT
SPACE
ENTER
BSPC
SHIFT
CTRL
ALT
SPACE
Print Screen SysRq
Scroll Lock
Pause Break
Insert
Home
Page Up
Delete
End
Page Down
Num Lock
Enter
Del
Ins
PgUp
PgDn
Caps Lock
Mic

Fig 13b

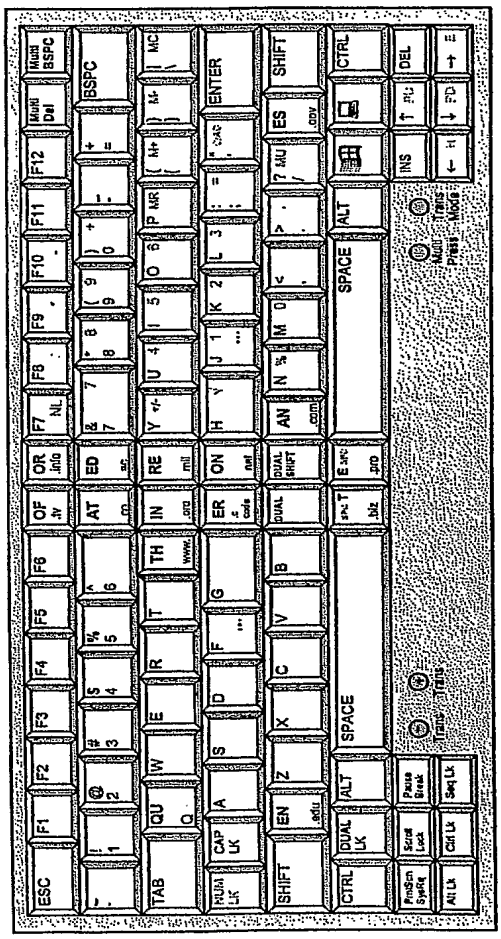


Fig 13c